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Washington February 1862

Hon. Charles Sumner U. S. Senator

Dear Sir

We have a vast mining interest, we also have a large national debt.

The development of the former will secure the easy payment of the latter.

The annexed book contains much information on the subject.

A few hours devoted to its perusal will prove useful, interesting and instructive.

I am dear Sir

most respectfully yours

Adolph Sutro

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VIRGINIA CITY, N.T.

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THE

MINERAL RESOURCES

Of the United States,

AND THE IMPORTANCE AND NECESSITY OF INAUGURATING

A RATIONAL SYSTEM OF MINING,

WITH SPECIAL REFERENCE TO THE

Comstock Lode and the Sutro Tunnel,

IN NEVADA.

BY ADOLPH SUTRO.

BALTIMORE:...JOHN MURPHY & CO.
1868.

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1868, Oct. 1.

Gift of

Hon. Hiram Barney.

(N. Y. 1830.)

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INTRODUCTORY.

THE development of the mineral resources of this country forms a subject of such grave importance, one involving considerations of a politico-economical nature of such significant consequences, that it well behooves the American Statesman, the Patriot who has the future of this great Republic at heart to devote some time to the earnest examination of those questions which have a vital bearing upon the future welfare of this country.

In the vast regions stretching from the Mississippi River to the broad Pacific Ocean, from the confines of Mexico to the icy regions of the North, there lie buried in the bowels of the earth incalculable treasures of the precious metals, which but await the industrious application of the hardy miner, and the fostering care of a providential government to pour out a stream of gold and silver, which will so much increase the national wealth, augment the resources of the nation, and spread welfare and prosperity throughout the extent of this vast land, *that the burdens of taxation will gradually disappear, and make the national debt sink into insignificance.*

If we contemplate that mighty interest, which can be made to create so many blessings, and find that it is neglected and declining from year to year, we must arrive at the firm conclusion, that there is something radically wrong in our present system of mining, and that an immediate, practical, and effectual remedy should be applied to rescue from steady decline and eventual abandonment a source of wealth *which must be considered the most fruitful and important one this nation possesses.*

If the facts presented in the following pages are carefully examined, three prominent conclusions will be arrived at:

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1st. That the main wealth of the mineral regions is contained in quartz lodes, the principal treasures of which are found at great depths beneath the surface.

2d. That the present mode of mining downwards from the surface, is detrimental to the prosperity of the mining interests.

3d. That a system of deep tunneling should be inaugurated, which will make mining profitable by giving a natural outlet to the flow of water, by ventilating the mines, by cooling the atmosphere, and by facilitating the extraction of ore.

Mining requires capital, which the western regions do not possess; the Eastern States have an abundance, but not for investment in mining enterprises, which are looked upon with suspicion, and are almost considered disreputable.

Some years ago many persons were found quite willing to embark in mining ventures, and considerable sums were invested; but the experiences made have been disastrous and ruinous to those concerned, in almost every instance. This result has been charged to various causes, but the true one must be sought in the unwise, extravagant and wasteful manner in which the work on the mines has been performed.

The construction of deep tunnels, which by all authorities are admitted to be absolutely necessary to make mining operations successful, require time, and the outlay of large amounts of capital, and consequently implicit confidence in the permanency of the mines.

It is the lack of confidence in the permanency of the mines, (their downward extent to great depth not having practically been demonstrated in the United States,) *which prevents the execution of such works.*

The Comstock Lode, the most productive of all mineral lodes in the world, producing as much silver as the whole Republic of Mexico, presents the most extraordinary example, illustrating the ruinous and wasteful manner of our present system of mining. We have a lode here which has produced within the last six years, over seventy-five millions of dollars, and the whole of that enormous sum has been swallowed up by the expenses of producing it! *The mines upon this lode have now reached such a depth, that, after a few years, they must inevitably be abandoned, provided a deep tunnel be not constructed.*

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Great mineral lodes, true fissure veins, according to experiences made in older countries extend downward indefinitely; we have the testimony of some of the first scientific men living, that the Comstock lode bears the strongest evidences of being a true fissure vein.

Here then we have a remarkable state of affairs; a lode yielding sixteen millions of dollars per annum, almost the whole amount being absorbed by the expenses of producing it, while the construction of a deep tunnel, for which extraordinary facilities exist, would leave one-half of that amount as a profit; the downward continuance of the lode is theoretically, at the same time conclusively, proven, and still we find that *capitalists* cannot be found to undertake the construction of a deep tunnel, because the ores at great depth are not actually visible.

Were that tunnel completed to-day, a glorious reality, pouring out a silver stream of forty or fifty millions per annum, these same *capitalists*, who first want to eye the riches way down in the earth before they consent to invest, would be eager to enter into similar undertakings in all parts of the mining regions, and tunneling would become the order of the day. *The nation would be enriched beyond all expectation, and the benefits to the Government and the people would be incalculable.*

That it is both the duty and the interest of the Government to aid in the construction of one such tunnel to serve as an index work, and thereby establish the continuance of mineral lodes in depth, cannot admit of any doubt.

The most favorable opportunity for such a demonstration presents itself in the construction of the proposed tunnel to the Comstock Lode; *the Government may consistently extend its credit to that work, for almost no risk is involved, the security offered being a hundred-fold;* a simple investigation of the subject will prove this conclusively.

Some thirty years ago, a similar question arose in Saxony, when *Baron von Herder*, then chief of the mining department, as an introductory to a book on the subject, addressed his countrymen in the following words:*

* The deep Meissen Tunnel, by Sigmund August Wolfgang, Baron von Herder. Leipzig, 1838.

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"TO THE FRIENDS OF THEIR COUNTRY

"Do I dedicate the plan of a mining work, the execution of which is of the "highest importance to the mining interests of Saxony.

"It is the plan to drive a deep tunnel from the level of the Elbe near Meissen "to the neighborhood of Freiberg, in order to drain the water from the mines of "that district to a much greater depth than heretofore, and by means thereof to "secure their existence for centuries to come: a plan which as to magnitude, time "and cost, is large and gigantic, but which appears in its effects and results so "benevolent and full of blessings, that the question as to cost should not form an "obstacle to its execution.

"It is true that the resources of the mining treasury of the Freiberg district are "too limited, to bear these expenses; *but the execution of a work which in times to "come will be classed in the list of those great national monuments, which have for "their object the lasting welfare of a country, and which will secure the same for "the latest generations and times, cannot be left to the mercy of a single mining "district, but should be looked upon as a work creating happiness and glory, and "worthy of the participation and promotion of the entire nation.*

"With unlimited confidence do I therefore present to the friends of their coun- "try, the following explanation and statement of this project:

"*May they extend to it a wise and sympathizing examination and magnani- "mous consideration, and may they be assured of the fervent thanks, which pos- "terity will grant them.*"

The mines of Saxony produced, and now produce but a mite of what our mines do; the national debt of that country is but small, and the burdens of taxation are not of an onerous character.

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How much stronger then should the argument be in the case at issue! A country containing more mines and richer mines than all the balance of the world combined; a country having a national debt amounting to over twenty-five hundred millions of dollars, and a people crying out and groaning under unequalled burdens of taxation!

Wisdom and foresight point out but one course; let the mineral resources of the country go to ruin, and the national debt, the burdens of taxation and general suffering will be increased from year to year.

Let our immense mineral resources be developed, an increase in the value of all property, a relieve of the burdens of taxation, unparalleled advancement of commerce, industry and traffic, a bright future, speedy resumption of specie payments, and general welfare and prosperity will be the results.

Those who rule the destinies of this country have the solution of this question in their hands; wisdom, foresight, liberality and true patriotism will grasp the issue, and promptly secure those results which will immensely benefit our present generation, and extend its blessings to posterity.

ADOLPH SUTRO.

WASHINGTON, D. C., *March*, 1868.

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JOINT MEMORIAL AND RESOLUTIONS,

ASKING GOVERNMENT AID IN THE CONSTRUCTION OF THE SUTRO TUNNEL.

Adopted unanimously by both Houses of the Legislature of Nevada, January 25, 1867.

WHEREAS, The State of Nevada contains within its borders a silver vein called the Comstock Lode; and

WHEREAS, A deep drainage and exploring tunnel, leading into said lode, is necessary to its permanent yield of the precious metals; and

WHEREAS, The character of said lode is now demonstrated to be such as to give ample security to the capital necessary to be advanced for its construction; and

WHEREAS, the following facts in connection with the foregoing are of weighty consideration:

That the mines on said lode have been worked for seven years last past, and during this time have produced sixty-four millions (64,000,000) of dollars.

That the present annual yield is sixteen millions (16,000,000) of dollars, an amount equal to the total annual product of the Republic of Mexico.

That the expenses of working these mines so rapidly increase with the increased depth, that the sixteen millions (16,000,000) of dollars were last year realized at a cost of fifteen million five hundred thousand (15,500,000) dollars; and at the present ratio of cost to production, their resources would, in a few years, be wholly absorbed, and the mines practically abandoned.

That the causes of increased cost are, amongst others, the accumulation of water in the mines, insufficient ventilation, and the increase of heat with depth; and that now having reached a depth of eight hundred (800) feet, these combined causes will prevent their being worked profitably, on the present plan, below twelve hundred (1200) feet.

That the Comstock Lode is conveniently placed for deep drainage, being situated on the side of a mountain, which declines into a valley, from which a horizontal adit or tunnel four miles long can be constructed, which will cut the mines at a depth of two thousand (2000) feet.

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That this tunnel once constructed, these mines can be profitably worked to a depth of three thousand (3000) feet; and by means of it, at least *one thousand millions* of treasure will be secured.

That the State of Nevada cannot render material aid to this indispensable work, by reason of Constitutional inhibitions.

That the mining companies, while producing large amounts of bullion, and distributing it into the channels of trade and commerce, under existing circumstances derive but an inconsiderable profit, and not equal, without Government aid, to the successful prosecution of such an undertaking.

That the taxable property of the United States has been more than doubled within the last eighteen years, and this increase has mainly resulted from the vast addition to the precious metals within this time; and the further addition of *one thousand millions* would be an increase to that extent of the public resources, and virtually a reduction, to a considerable extent, of the public debt.

That the United States contain, by estimation, one million square miles of mineral land, the chief value of which is to be found at great depths from the surface; and what is now wanting to enlist private enterprise in the aid of deep mining, and thus develop incalculable wealth, is a practical proof, upon such a scale as the proposed tunnel would furnish, that our mines are continuous to the lowest levels at which drainage can be secured.

That in all European mining countries, the aid of Government is given on broad financial considerations, to enterprises of this and like character.

That the magnitude of the proposed work and the results to flow from its completion, as favorably affecting great financial questions, justly assign to it a national consideration. Therefore,

Resolved, By the Senate and Assembly of the State of Nevada, conjointly, that our Senators be instructed, and our Representative requested, to use their best endeavors to obtain from Congress such material aid as will secure the speedy construction of the deep drainage and mining tunnel known as the Sutro Tunnel.

Resolved, That the Governor be requested to transmit a copy of the foregoing preamble and resolutions, together with the Reports of Committees, to each of our Senators and to our Representative in Congress.

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THE COMSTOCK LODE,

AND THE

EVILS OF OUR PRESENT SYSTEM OF MINING.

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THE COMSTOCK LODE.

THE Comstock Lode in the State of Nevada is situated on the eastern slope of a range of hills, east of, and running parallel with, the Sierra Nevada mountains; from its outcroppings the hills slope down to the valley of Carson river.

A TRUE FISSURE VEIN.

The Comstock Lode is a true fissure vein, several miles in length, from one hundred to two hundred feet in width and extending from the surface downward, at an angle of forty-five degrees, to indefinite depth.

The predominating metal of the Lode is silver, which constitutes about two-thirds in value of the bullion; the other third consists of gold.

MINING COMPANIES.

On this great vein, which was discovered in the year 1859, some thirty-five companies own claims, amongst which we may mention: The Ophir, Mexican, Gould & Curry, Savage, Hale & Norcross, Chollar Potosi, Imperial, Empire, Confidence, New-York and Washoe, Yellow Jacket, Crown Point, and Belcher.

Each company owns a given number of feet, from ten to fourteen hundred, along the length of the Lode, and is entitled to all the ore contained between the sides or walls of the fissure, with all its dips, spurs, and angles, and within its north and south boundaries, to any depth it may be possible to carry mining works.

YIELD OF BULLION.

This great vein, the most important one at present worked in the world, and probably the most prolific one of which we have any historical record, has yielded in the last six years to January 1st, 1868, $75,000,000.

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Its present annual yield is about *six hundred thousand pounds avoirdupois* of gold and silver bullion, worth $16,000,000, equal to over one quarter of all the gold and silver produced by all the States and Territories on the Pacific coast, or equal to one-third of all the silver produced per annum in the whole world, and *exceeding the present total yield of all the silver mines of Mexico.*

IMPORTANCE TO NEVADA.

The importance of the Comstock Lode to the State of Nevada will be well understood, when it is considered, that, as the Comptroller's books of the State for 1865, showed, the taxable property of the five counties surrounding the Comstock Lode, and which derive their entire value from these mines, amounted to $24,238,061—*while all the rest of the State of Nevada, embracing eighty thousand square miles, with its thousands of mines, had only* $5,499,315 *of taxable property.*

THE FIRST MINE IN THE WORLD.

The Comstock Lode is pronounced by competent geologists to be a larger, more extensive, and more permanent vein, than either the celebrated Veta Madre of Guanajuato, or the Veta Grande of Zacatecas, both of which have poured out their treasures for the last three hundred years, the former having yielded about $800,000,000, the latter over $650,000,000.

A larger interest is concentrated here within the compass of a few miles than on any other spot on the globe; and the continued productiveness of these mines is a matter which not only concerns the State of Nevada, or the Pacific Coast, but *the whole United States and the commercial world at large.*

COST OF MINING.

Notwithstanding the immense yield of these mines they are in the aggregate a source of but little profit—for it almost costs $16,000,000 per annum, expended in pumping out the water, extracting the ore and reducing it, to obtain $16,000,000 worth of bullion; this will be readily understood, when we

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consider, that these mines have already reached a depth of from seven to eight hundred feet, and in some instances nine hundred feet, and that every pound of water and ore has to be hoisted that distance. Forty-seven steam-engines are constantly at work on the mines, day and night, and every cord of wood consumed has to be purchased at the rate of sixteen dollars in gold.

APPROACHING ABANDONMENT.

Many difficulties are encountered in mining downward through perpendicular shafts, and experience in all places and at all times has shown, that mines at some time reach a depth *where the constantly increasing cost of mining exceeds the yield*, and it is the uniform opinion of mining engineers, that *that* depth has nearly been reached on the Comstock Lode, and if no other means for draining and working the mines be adopted, that this property but a short time ago worth $25,000,000, including its surroundings, will thus become entirely valueless for all practical purposes, *and deprive one hundred thousand people of their occupation and means of subsistence.*

This result is most clearly foreshadowed in the enormous but steady decline of the shares in nearly all the Comstock mining companies, *a fact so notorious as to be absolutely beyond question.*

THE REMEDY—A DRAIN TUNNEL.

But nature, which has placed these mines two thousand feet above the adjacent valley, has thereby provided the means to run or construct a horizontal adit or tunnel, which would cut the mines at a depth of two thousand feet below the croppings, and which would remove all the obstacles at present encountered, by giving a natural outlet to the flow of water, and extending facilities for working the mines. *Such a tunnel would place these mines in a condition to be worked profitably and economically for a hundred years to come, and would secure to the world many hundreds of millions of dollars in gold and silver.*

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QUANTITY OF WATER.

It has variously been estimated that the quantity of water at a depth of 1,900 feet, draining the Comstock Lode from its extreme northern to its extreme southern end, (judging from the quantity now running down the canons, and which issues from the various tunnels, or is pumped out of the mines,) would form a stream of 3, 4, 5, 6 and even 10 square feet, flowing at the rate of five miles per hour. Taking the lower figures 3 square feet, that is to say, a stream of water which would fill a trough or canal three feet wide and one foot deep, flowing at the rate of 5 miles or 26,400 feet per hour, we get 26,400×3=79,200 cubic feet of water per hour, or *per minute* 1,320 cubic feet=8,226 imperial gallons.

COST OF PUMPING IN NEVADA.

The estimates made on the cost of generating steam power at Virginia City, vary somewhat, but the lowest figures given are at the rate of $1 50 per twenty-four hours for every horse power. Taking the quantity of water as above stated, we have 1,320 cubic feet at 62½ lbs., equal to 82,260 lbs. *per minute.* This sum divided by 33,000 gives 2½ horse power, to lift the given quantity 1 foot high; in order to lift it 1,550 feet, (allowing 350 feet for tunnels in existence now,) it would require 3,859 horse power. Now it takes about double the given power to overcome the friction of water in pipes, the friction of pumps, etc., etc., and it would consequently take 7,718 horse power, to raise the stated quantity of water from a depth of 1,900 feet to the level of the existing tunnels, 350 feet below the surface. At $1 50 per day for every horse power, it would cost to keep the requisite pumping machinery in motion $11,577 per day, or $347,310 per month, or $4,167,720 per annum, *without allowing anything for the interest on the money invested in machinery, and its original cost, which would amount to several millions of dollars.*

Captain Taylor some time ago furnished the following figures, as to the cost of pumping at the Best & Belcher Mine, the pumping machinery of which was

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among the best, and as economically conducted as any in Nevada. His daily expenses in pumping were:

Wood 2½ cords at $16,	$ 34 00
Engineer's wages,	12 00
Pitman's wages,	9 00
Oil, leather, etc.,	5 00
Interest on cost of machinery $42,000, at 2 per cent. per month—per day,	28 00
Total,	$ 88 00

The engineer's and pitman's wages would be somewhat less in large pumping works, but not having brought into account any allowance for wear and tear, no great difference would arise therefrom.

He raised the water 270 feet, and discharged 253 gallons per minute; at a depth of 1,550 feet, it would have to be raised $5\frac{7}{27}$ times as high, equal to a daily expense of $505 12. But the quantity at that depth for the whole Comstock Lode as estimated above, will be $32\frac{7}{27}$ times as great. To pump out the same would therefore cost $32\frac{7}{27} \times \$501\ 60 = \$16{,}421$ per day, $492,630 per month, or the enormous sum of $5,911,560 per annum.

These are astonishing figures, but they are nevertheless correct; we may therefore safely put down *the cost of pumping out the water from the Comstock Lode at a depth of* 1,900 *feet, at the average of the above given sums, which would be a trifle over five millions of dollars per annum;* and all this enormous sum is totally wasted, for the moment the pumps stop, the mine fills with water, and all the money expended for pumping is completely lost.

This sum squandered every year for pumping, applied to the construction of a tunnel, would forever allow the water to flow off by a natural outlet, and would secure profitable mining operations for centuries to come.

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EVILS OF PUMPING.

Independent of the actual cost of pumping, there are other disadvantages connected with the same, which must not be lost sight of. *Engines, boilers, pumps, etc., etc., rapidly wear out,* and new ones have to take their places; pumps are liable to get out of order, and being placed at the very lowest point in the mine, if not instantly repaired, the water rises, making it impossible to reach them.

In consequence of these accidents, the mines will be flooded frequently, and delays occasioned of days, weeks, or even months, throwing the miners out of employ, stopping the mills, and cutting off dividends; thus creating great hardships in all quarters.

But these are not the only evils arising therefrom: the filling of the chambers and galleries with water swells the ground and timbers, which after the water is removed shrinks, *and consequently leaves the mine in an insecure state, making it liable to cave in.* Miners in distant parts of the mine remain in a constant state of anxiety, fearing some accident to the pumps; they can never work with that feeling of security they would otherwise possess.

Another objectionable feature to using machinery is the fact that the mine which reaches the greatest depth *is compelled to do most of the pumping,* not only for itself, but also for its neighbors, thus draining their mines without receiving any remuneration. This will retard mining operations to a large extent, as many companies would prefer to suspend the working of their mines until the adjoining claims have reached the same level.

The annual consumption of timber for supports in these mines amounts to sixteen millions feet board measure, which cost $35 per thousand feet or $560,000, and the total quantity thus far placed in them may safely be estimated at one hundred millions feet, costing $3,500,000.

This forest of timber, the wood being of yellow pine, increases every year and may be made to last 12 or 15 years, provided a dry fresh current of air

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passes through the mines, *while it will rot in three or four years in damp, ill ventilated places.* That no favorable conditions for its preservation exist, may be concluded from the fact, that several of the mines have lately caved in, and that half the houses in Virginia City are cracked in such a manner, that it is dangerous to live in them. *A drain tunnel would remedy all these evils.*

INCREASE OF HEAT.

Another great obstacle in deep mining is the increase of heat with depth. It is a well ascertained fact, confirmed by experiments all over the globe, that the increase of heat in penetrating the earth's crust amounts to one degree of Fahrenheit for every 60 feet of descent. This has also been experienced on the Comstock Lode, and it may be stated as an illustration, that the workmen in the Belcher mine, in running a drift from the 900 feet level a short time ago, *could only work five minutes at a time without stopping to rest, so excessive was the heat.* Any person who has descended into any of the mines on the Comstock Lode within the last year will bear testimony, that the heat, even at the present depth, is excessive, and no one can remain there for half an hour, without being bathed in perspiration.

The pecuniary loss from this cause must be considerable, for no human being can perform the same amount of labor with the thermometer at 95 than if it stood at 65 degrees. 3,000 miners are employed at $4 00 in gold per day, making an aggregate expenditure of $12,000 per day for that kind of labor; their working capacity would be increased at least 25 per cent. were they to have a cool atmosphere, and the consequent loss therefrom amounts to $3,000 per day or to *over one million of dollars per annum!*

VENTILATION.

This is a subject of so grave a character, that in England committees have been appointed from year to year by Parliament, to investigate the state of the mines with especial regard to ventilation and the health of the miners.

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These reports show, that an alarming number of persons die of miners' consumption, as the result of being compelled to work in a foul atmosphere. In the mines of the Comstock Lode it is a common thing to enter a drift, where a candle will hardly burn, and in this poisonous atmosphere—deprived of oxygen, without which no human life can exist, the miner is compelled to delve and toil for eight mortal long hours!

Legislation should remedy so barbarous a state of affairs and a whole nation should assist in removing an evil, which can be so effectually removed by the construction of a deep tunnel, which, after being connected from the surface by shafts, would create a draft and circulation of air as effectual as a chimney would 2,000 feet in height. Such a current could be carried to the remotest parts of the mines, *bringing a welcome supply of fresh air, cooling the atmosphere, giving health and vigor to the miners, and saving millions of dollars every year.*

TUNNELS IN EUROPE.

For all these reasons, and many others which it would be too lengthy to enter into, *the Governments of Europe for centuries past have favored, assisted and taken in hand the construction of deep drain tunnels, wherever the topography of the country allowed it.*

A few years ago the great "Ernst August" tunnel to the Harz mines in Germany, was completed; a writer on that occasion, in reviewing the history of those mines, said:

"Already in the beginning of the sixteenth century, the mechanical appliances for raising water were found to be insufficient, and it was considered a matter of necessity to construct drain tunnels. The first one, called the Seventy-eight feet Tunnel, was completed in 1525, the Frankensharner Tunnel in 1548, the One Hundred and Fourteen Feet Tunnel in 1551, and the Raven Tunnel in 1573. By means of these tunnels, which were connected with all parts of the mines, it was found possible to work them for about two hundred years; but toward the end of the last century it became impossible to master

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the water, and in consequence it was concluded, in the year 1771, to run a still deeper tunnel; work was commenced in 1777, and it was completed in 1799. It is called the Deep George Tunnel, and its length, including cross-cuts, is fifty-seven thousand feet; it drains the mines under Clausthal to a depth of nine hundred feet.

"This relieved the mines from water for a while, but as work progressed and greater depth was attained, the flow of water increased so rapidly that the grandest pump-works were found to be insufficient.

"The topographical features of the country are such that no deeper drainage could be obtained, except at an apparently impracticable distance, and in consequence the danger was imminent, that these mines, which had supported thousands of persons for centuries, would shortly have to be abandoned entirely.

"THE ERNST AUGUST TUNNEL.

"In the year 1850, the plan to commence a tunnel in the Dukedom of Brunswick, at a place called Gittelde, which would give a deeper drainage, of about three hundred feet, below the Deep George Tunnel, or a depth under the church of Clausthal, of about one thousand two hundred feet, was determined upon. Surveys were made and the distance found to be seventy-two thousand feet, or about *fourteen miles*, and the time to complete it was estimated at twenty-two years. On the 21st of July, 1851, work on this great tunnel called after the late king, the 'Ernst August Tunnel' was commenced by the Government of Hanover, and on the 22d of June, 1864, the last connection was made; it therefore took only twelve years and eleven months to complete this great mining work."

YIELD OF THE HARZ MINES.

It may as well be stated here, that the mines of the Harz produce about $500,000 in precious metals per annum, an amount taken from the Comstock every fortnight. *Now, if they found it a matter of necessity and economy to*

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run a tunnel fourteen miles long in the Harz mountains, in order to obtain an additional drainage of three hundred feet, in a country where fuel is cheap, how evident must it appear, that a tunnel to the Comstock, less than four miles in length, which will give drainage to a depth of two thousand feet, and which would secure the future working of the richest mines in the world, must prove of great benefit.

OTHER GREAT TUNNELS.

At Freiberg in Saxony, the mines would have been abandoned hundreds of years ago, had it not been for the drain tunnels, constructed *by the Government* from time to time, and which had a total length of 97 miles when the Rotheschoeneberger Tunnel was commenced; this will be eight miles long, but is not quite completed yet, while a much deeper one, the Meissen Tunnel, 24 miles long, has been projected and advocated by the principal mining engineers and experts of Germany.

In Hungary, at the celebrated mines of Schemnitz, a drain tunnel exists, called after the Emperor Joseph II, which has a length of over 9 miles.

In England, where mining is carried on in the most intelligent manner, the slight elevations above the sea-level do not allow of deep drainage by adits; but wherever any elevation exists, it has been taken advantage of. Thus we find at the United Mines near Redruth, in Cornwall, a drain tunnel which has a length, including its branches, *of from thirty to forty miles*, while its greatest depth under the surface at any one mine is *four hundred and twenty feet*, and the average of depth under all the mines only *one hundred and eighty feet.*

Besides these a great number of tunnels exist in different mining districts, mostly constructed at Government expense, which it is unnecessary to enumerate here; some of them are mentioned in the different letters from European experts attached hereunto.

THE SUTRO TUNNEL.

The mouth of this tunnel is situated in the valley bordering on Carson river, three miles northerly from the town of Dayton.

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In order to expedite the work, it is proposed to sink four shafts on the tunnel route to the tunnel level, which will be about four thousand feet apart. From the bottom of each of these shafts the tunnel will be constructed by drifting each way toward its mouth, and toward the Comstock Lode; thus nine points are obtained to work upon at the same time.

The Comstock Lode runs north and south; the tunnel from east to west; it therefore cuts the lode at right angles. After reaching the lode, drifts will be extended along the same, northerly and southerly, in order to reach each mining claim.

The main tunnel will have a length of	21,178 feet.
The main branches (as far as the Comstock Lode is now explored from the Utah mine to the Uncle Sam) will have a length of	17,688 "
And the shafts which it is proposed to sink, will have an aggregate depth of	4,220 "
Making a grand total of	43,086 feet

of tunnel and shafts to be constructed.

DIMENSIONS OF THE TUNNEL.

It is proposed to make the tunnel about twelve feet square and provide it with two substantial railroad tracks; one to run cars in, the other to run them out; under the track a drain will be constructed for the purpose of carrying off the water.

The cars which will have a capacity of five tons, will be propelled by means of a wire rope, set in motion by a stationary engine at the mouth of the tunnel.

The calculations on the cost of construction, have been made in an elaborate report by the Chief Engineer, R. G. Carlyle, Esq., who estimates the same at one hundred dollars in gold per running foot, including the sinking of shafts, and states the time in which the main tunnel may be completed at 3½ years. But it is so well known, that in large works, especially of this character, many difficulties are encountered, which cause delay and increase the cost, that we must also expect it in this instance.

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GEOLOGY OF THE COUNTRY.

The country through which the tunnel passes, offers no serious obstacles to its construction; the different formations are remarkably favorable for that kind of work, and consist of volcanic tufa, trachytic breccia, trachyte and greenstone porphyry, the latter in a decomposed state; the Mount Cenis tunneling machine will make rapid progress in these rocks.

For further details concerning the geology of the country, we refer to the able report of Baron Richthofen, a European geologist well known to the scientific world.

ADVANTAGES TO BE GAINED.

The principal advantages to be gained by the construction of the Sutro Tunnel are:

1st. All pumping machinery may be dispensed with as soon as the tunnel is completed, for the shafts now existing on the Comstock Lode *may at once be connected with the tunnel by boring*, which is at the present time accomplished rapidly and at small expense, *thus draining off the water from the shafts and permitting their connection with the tunnel without delay.*

2d. The moment this connection is accomplished the most perfect ventilation is insured, drawing off the fumes of powder and foul, damp air, at the same time *cooling the atmosphere, giving health and vigor to the miners and preserving the timber.*

3d. The mines may thereafter be opened by numerous galleries to the whole depth of 2,000 feet, thus showing the different bodies of ore contained in the same, *exposing many millions of treasure to the eye and increasing their value in proportion.*

4th. It will give a great impetus to the exploration of those mines, which have thus far been unproductive, particularly those located at the northern and southern extremities, and which have been lying idle *for the want of means to erect the requisite steam pumping engines.*

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5th. For the reasons already stated, the extraction of ore will be so much facilitated and stimulated, that the present production of sixteen millions of bullion *may be increased to, or even be made to exceed, fifty millions of dollars per annum.*

6th. Not only the pumping engines may be dispensed with, but also those used for hoisting; for after the shafts are connected, instead of hoisting the ore to the surface on the side of the mountain and then transporting it to the valley by means of wagons, it will fall down to the tunnel level by its own gravity, while a railroad in the tunnel will carry it to the reduction works, which are mainly located near Carson river.

7th. By this great saving in extraction and transportation alone, independently of all the other advantages of the tunnel, *it will be made possible to take out the immense bodies of low grade ores, which are known to exist in the Comstock Lode,* and which may be concentrated by means of the water which the tunnel itself will furnish. The millions of dollars contained in these ores, will, without the tunnel, *forever remain slumbering in the bowels of the earth,* for the expenses of extraction under the present costly system are greater than the value they contain.

8th. After the completion of the tunnel the mines may, without the use of steam engines, be worked to great depth below the level of the tunnel, by conducting the water, which may be collected on the surface from rain and melting snows, together with that contained in the mines, to hydraulic engines placed in the interior of the mines, *thus using a portion of the very water, which causes all the trouble at present, as a most economical and useful motive power to propel pumps, which raise the water from great depths below, and discharge it through the tunnel.* According to Professor Weïssbach, the highest living authority, fifty gallons per second, introduced at the surface, will give 1,800 horse power at a depth of 2,000 feet! It may safely be stated, therefore, that by means of this tunnel the Comstock Lode may profitably be worked to a depth of at least 3,500 feet, a greater depth than has yet been reached on any mine in the world.

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9th. The tunnel creating all the advantages above enumerated for the Comstock Lode, will, besides, open up all the country lying to the eastward of the same.

That numerous parallel ore-bearing lodes exist in the porphyretic belt, is well known to every miner who has examined the ground; but independently of those which are already known theory and analogy, with other mining districts, make it almost a certainty that many veins (blind lodes, as the miner calls them, for they do not reach to the surface) will be discovered and opened.

In a mineral-bearing region the hopes of discovering such by running horizontal adits into a mountain are generally well founded; but nowhere on the face of the earth do we find a mountain-range containing a vein as valuable as the Comstock Lode, and *having a formation equally favorable for the existence of a series of similar veins.* It is not only reasonable to suppose, but quite evident, that the immense convulsion which rent the earth in twain, and created the fissure which is known as the Comstock Lode, at the same time must have cracked and opened the earth's crust in many other places, and filled the same with precious minerals.

A NATIONAL QUESTION.

It is evident and conclusive from the foregoing pages, that the construction of the proposed tunnel to the Comstock Lode, *is an absolute, imperative and immediate necessity, and that it involves considerations of a politico-economical nature, much more important* than at first glance may seem to appear.

The question next arises how to carry out so gigantic a work, one so novel and different in its character from any heretofore proposed in the United States.

Years have been spent already in indefatigable and unceasing efforts to induce private capital to undertake the task; the mining companies, the people of Nevada and California, the capitalists of New York, Boston, Philadelphia, Baltimore, and those of London, Paris, Brussels, Amsterdam, Berlin, Vienna and other financial centres have been appealed to, and the most favorable propositions placed before them, but to no avail.

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All mining is looked upon as hazardous in itself, and funds are with difficulty obtained for enterprises of that kind; but when the question comes up to raise millions of dollars for a single mining work, one that may give no returns for years, *it becomes absolutely impossible to induce private capital to undertake it.*

What then remains to be done? The most important and productive mines, which the world can show, are on the eve of absolute ruin and abandonment; an interest upon which the fortunes of an entire state are depending; one which supports more than one hundred-thousand people; an interest which furnishes the life-blood of commerce and industry, and which helps to pay *the national debt;* an interest which has been looked upon by all civilized nations, as first in importance to be sustained and encouraged—will go to cureless ruin, if no immediate steps are taken to remedy the threatening evil.

Will the American Nation, the most intelligent, powerful and liberal one on earth, quietly look on and not come to the rescue?

The question involved is of a national character; it is one which interests one section of this great country as much as another. The people of Maine and Alabama, those of Illinois and Pennsylvania, should feel as deep an interest in the execution of this great work, as those of Nevada and California.

This country embraces millions of acres of mining land, containing veins of gold and silver, the value of which lies in great depth, but the mining interests droop; the production of the precious metals grows less from year to year; the placers or surface diggings are, to a large extent, worked out or will be so before many years; capital cannot be found for investment in *quartz mining*, and half the mining camps are deserted.

The causes for this decline may readily be seen; mining operations have mostly proved unprofitable, and the serious losses sustained makes people timid to repeat the experiment.

The extravagant and wasteful manner of working the mines, accounts for most of these failures; the sole object of mining seems to be an eager haste to grow rich at once, and *no confidence exists for the construction of tunnels*, by

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the aid of which alone a rational system of mining can take place, *because it has never been demonstrated in this country that mineral veins extend to great depth.*

What is now required to restore confidence and to stimulate this vast interest, is the actual demonstration of the continuance of mineral lodes in depth, and no work would prove the same more conclusively than this tunnel to the Comstock Lode.

The Government is asked, not to establish a precedent of assisting mining enterprises generally, but to assist *one grand index work*, and the miners of the Western States, by common consent, look upon this work as the one selected to receive that aid.

If we could once demonstrate that a lode extends downwards more than two thousand feet, and is ore bearing, private capital will not be wanting to enter into similar operations throughout the mining regions, and the result will be the inauguration of a new and lasting system of profitable mining, which will add untold millions to the stock of the precious metals of the world.

But as a consequence of this important consideration, a graver one, and one which should be foremost in the heart of every American, *is the influence which this great production of the precious metals will have upon the payment of the national debt.*

That subject has been so thoroughly and ably treated in the report of the Committee on Federal Relations of the Nevada Legislature, made in memorializing Congress to aid the Sutro Tunnel, and which is attached hereunto, that it would be a repetition to enter into the subject here, and special reference to the same is therefore made.

The General Government will not be asked to construct the work in question, all that is required is, to have it extend its credit as the work progresses; and after its completion *the total proceeds will be applied to the repayment of the capital and interest.*

The security given to the Government will be quite ample to remove any objections as to risk, for even should not a single ton of ore be found at great depth, *there are now visible in the mines four millions of tons low grade ores,*

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valued at eighty millions of dollars, which but await the completion of the tunnel to be profitably extracted.

The Government is consequently simply called upon to extend its good will towards the accomplishment of so great a work, *for little risk is involved*, and every dollar guaranteed will be paid back years before any part of the capital falls due.

Every European Government has extended similar aid to similar enterprises, and there is no good reason why the American Government should hesitate for a moment, to pursue the same course in this instance.

Little Saxony has constructed more than a hundred miles of tunnel; Hanover almost an equal length; *will this great American Nation refuse to assist in the construction of a tunnel five or six miles in length?* One that involves an interest a hundred fold greater, and that will result in blessings to every portion of the country? We say no; this appeal from the State of Nevada, which in her tottering infancy, requires the strong arm of support of her older sisters, cannot be made in vain.

May the American statesmen carefully consider the question at issue, may they fully appreciate the important results to flow from so great a work, and may they render that assistance, which alone will insure these results.

The words spoken by the greatest scientific mind of the century, in regard to a like undertaking in Saxony, are worth remembering.

Alexander Von Humboldt said:

"I may be permitted to add, that a subterranean work so bold and gigantic should lend an elevating feeling of moral strength to a people, who do not estimate their own worth by the number of souls, but by their patriotism, that is, by glorious historical recollections and by the laws created under a liberal constitution; this feeling becomes particularly important in times, when every body strives to a paltry appeasing of momentary wants, and an undertaking, which in contrast to this strife, creates for a distant future, must appear ennobled and of superior relations."

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Letters from Distinguished Experts.

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LETTERS.

LETTER FROM FRANCIS BOWEN, PROFESSOR AT HARVARD COLLEGE.

Harvard College, Cambridge, Mass., Dec. 23, 1867.

Adolph Sutro, Esq.

DEAR SIR:

The question about the practicability and the probable cost of the Sutro Tunnel is one that I am not competent to answer. The problem can be resolved only by able engineers, who have carefully surveyed the locality.

But of the great utility of the work, when completed, there can be no doubt. It will rescue from threatened decline and abandonment a great national enterprise, which has added within a few years over fifty millions to the stock of precious metals in the world, and probably will soon add many times as much more, if the necessary means can be obtained for its continuance.

Congress cannot do better, than devote two or three millions to the rescue of so noble an undertaking, the regular prosecution of which will gradually lessen the burden both of private and public indebtedness throughout the civilized world, and promote the activity of commerce and manufactures for many generations.

Very respectfully, yours,

FRANCIS BOWEN.

LETTER FROM BARON VON BEUST, CHIEF OF THE MINING DEPARTMENT OF THE KINGDOM OF SAXONY.

Freiberg, October 26, 1867.

Mr. Adolph Sutro, of Nevada, in the United States of North America, has submitted to me the project of a deep adit under the name of the Sutro Tunnel, which is to be constructed for the purpose of draining the mines of the Comstock Lode, and for the opening up of new mines in that mountain range, and desires to have my views in regard to the same.

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After examining the matter submitted, I do not hesitate to declare, taking the correctness of the facts stated therein for granted, that the projected deep adit should be designated as one of the most healthy, most useful and most hopeful mining enterprises, which could possibly be undertaken, and for that very reason deserves the highest consideration in a financial, politico-economical and scientific view. I must particularly coincide with the renowned Baron Richthofen, who has a thorough knowledge of the mining operations on the Comstock Lode, in what he says on page 77 of his book: "The Comstock Lode," San Francisco, 1866:

"The only possible way of attaining these results is the construction of a deep adit level or drain tunnel, as it is called by the Washoe miners. There is probably no silver mine in the world, which offers so great facilities and inducements for the performance of such a work."

While the most important, most brilliant results of the construction of a deep adit could not be doubted, even should the ores of the Comstock Lode and similar neighboring lodes lose considerable of their value in depth, it may, on the other hand, be predicted with somewhat mathematical certainty, that these mining operations, even with pretty rich ores, will, at no distant day, go to certain ruin, should no tunnel be constructed.

The reasons therefore are so much at length and clearly stated in the quoted report of Von Richthofen, that it does not here require a repetition of the same. A deep adit of the proportions of the Sutro Tunnel, having a length of 6,000 metres, together with four shafts of a probable entire depth of 1,200 metres, which have to be provided with steam engines, could not in very favorable rock formations, as they are said to exist in the Comstock range, be constructed in Germany for less than one to one and a quarter millions of thalers; with the prices of American labor and fuel, as they exist in that neighborhood, three millions of dollars may therefore be considered as a fair estimate.

In regard to the time required, I should not like to estimate it at less than eight years, at the same time basing my calculations upon very favorable rock formations, great energy in execution, and the non-occurrence of special casualities, which may occur in such operations, notwithstanding all precautionary measures.

But this expenditure of three millions of dollars and eight years of time, which, as already stated, I simply put down as the probable result from very

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general experiences, would, according to my views be *insignificantly small contrasted with the results*, which would be achieved thereby, particularly if not only the direct financial advantages are taken into consideration, but also those of a politico-economical nature, which would consist in having placed for all times, on a solid foundation, the most extensive gold and silver mines, which are known to modern times.

BARON VON BEUST,
Chief of the Mining Department
of the Kingdom of Saxony.

LETTER FROM BERNHARD VON COTTA, PROFESSOR OF GEOLOGY AT THE MINING ACADEMY OF FREIBERG.

Freiberg, October 31, 1867.

Adolph Sutro, Esq.

Hotel d'Angleterre, Berlin.

MUCH ESTEEMED SIR:

After having read Von Richthofen's superb treatise on the Comstock Lode, which, as far as the establishment of facts is concerned, thoroughly bears the seal of truth, I feel justified in answering your four questions, from a full conviction, as follows:

1st. It is beyond doubt, that the Comstock Lode, as a genuine fissure vein, will continue downwards in greater depth, than it will ever be possible to reach by mining, and that this mighty deposit within any depth, which can be attained, will be ore-bearing in the manner Von Richthofen supposes.

2d. Accordingly there can be no question about it, that the opening up of the lode by a deep tunnel, will facilitate, to quite an extraordinary degree, mining upon the same, and in every other regard make it more profitable.

3d. The advantages in working the mines upon the Comstock Lode by means of the tunnel proposed by you, (the Sutro Tunnel,) will, as concerns the main lode, principally consist of:

a. In facilitating drainage and ventilation.

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After all the mines are connected with the tunnel, no engines will any longer be required for this purpose, and even before such connections are established, the completion of the tunnel would likely drain off considerable water through the fissures of the lode.

b. In facilitating transportation, not only of the ore from the mines, since reduction works may be established near its mouth, but also of the materials and timbers required in a portion of the mines.

c. In facilitating the entry and exit for a portion of the miners.

d. In any case the possibility will be acquired by means thereof, to work the lode to a much greater depth, than without the tunnel.

N. B. The concentration of ores in the neighborhood of a river, can in all probability, also be attained better and more advantageously, than on the side of the mountain.

It is probable in the highest degree, that the tunnel will open up new and similar lodes, which in this neighborhood seem to run mainly from north to south, and which will be found particularly in the rocks which form the hanging wall, eastwardly from the main lode.

BERNHARD v. COTTA.

LETTER FROM JULIUS WEISSBACH, DR. PHIL., ROYAL SAXONIAN MINING COUNCILLOR AND PROFESSOR AT THE MINING ACADEMY OF FREIBERG.

Freiberg, October 28, 1867.

Adolph Sutro, Esq., from California,
at present at Berlin, Hotel d'Angleterre.

MUCH ESTEEMED MR. SUTRO:

My views on your tunnel project to the rich silver mines of the Comstock Lode, etc., etc., in Nevada, are briefly, as follows:

The geological and topographical position of the Comstock Lode is of such a character, that the execution of the projected tunnel will not only save the mines from approaching abandonment, but will be the means of very largely increasing their yield.

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A tunnel, which, with a length of about one German mile, opens up rich ores at a depth of two thousand feet, secures to a professional mining engineer the most welcome and surest means for profitable operations, particularly in a country where no cheap fuel exists for the purpose of generating steam power. Such a tunnel removes, *firstly*, the necessity of using pumping engines for many years to come. It facilitates and cheapens, *secondly*, the extraction of ore and waste rock in an extraordinary manner.

It gives furthermore, *thirdly*, many opportunities for additional exploration of the country, and discovery of new bodies of ore. The tunnel also, *fourthly*, makes it possible to derive a profit from the great masses of poor ores.

The connecting and air shafts of the tunnel, will, *fifthly*, secure to the mines perfect ventilation. Finally, there will be created, *sixthly*, a motive power, by saving the water on the surface, and conducting it to hydraulic machines, for instance, turbines, water pressure engines, etc., placed in the mines, which let the water flow off on the tunnel level, after having done its duty, and which not only will entirely remove the necessity of steam engines, but also promise the greatest profit, particularly if the supply of water can be made to last the year round.

With a fall of two thousand feet, the working power created by one gallon alone=$\frac{1}{8}$ cubic foot=10 lbs. water *per second* is equal to 20,000 lbs. for every foot, that is=$\frac{20000}{550}$=36 horse power. A quantity of water of fifty gallons introduced per second would therefore create a working capacity of eighteen hundred horse power.

May this distinguished mining project soon enjoy the greatest patronage; it deserves the same in the highest degree, it is surely the only means of bringing mining operations on the Comstock Lode into a flourishing condition, and of securing their being carried on to great advantage for a long time to come.

With especial esteem, yours,

JULIUS WEISSBACH,

Royal Saxonian Mining Councillor and Professor.

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LETTER FROM HIS EXCELLENCY DR. H. VON DECHEN, ACTUAL PRIVY COUNCILLOR OF THE KING OF PRUSSIA AND LATE CHIEF OF THE MINING DEPARTMENT.

Bonn on the Rhine, Nov. 1, 1867.

Mr. Adolph Sutro,

Hotel Munsch, Vienna.

I have no doubt that my answer to your letter of the 29th inst. reached you yet at the Hotel d'Angleterre, Berlin, in which you find a complete confirmation of the views you express in your letter of the 30th inst., which is before me, as regards financial aid to your project in Prussia.

Agreeable to your request, I may be permitted to state, that the plan of constructing a deep tunnel to the most important gold or silver mines on the Comstock Lode in the state of Nevada, entirely corresponds with the approved rules of mining engineering and will carry with it the most happy results.

The new improved methods in sinking air shafts and driving tunnels, remove the objections, which for a time have been made against deep and therefore long tunnels, and which were, that the construction of such tunnels would require too much time and its benefits would only be felt in after years.

The time required is reduced to one-third or even one-fourth compared to the old methods, by means of boring machines, which are used with the best results not only at the tunnel of Mont Cenis, which will have a length of forty thousand feet, but also at the zinc mines of Altenberg Moresnet, near Aix la Chapelle, and at the coal mines near Saarbrücken, and by means of blasting oil (nitro-glycerine) in the place of blasting powder.

The Sutro Tunnel can consequently be constructed in a few years and will exercise its blessings for the whole period the Comstock Lode shall be worked, which period will thereby be lengthened, as much as it is in fact possible. *Similar works have been carried out in Prussia, partly by the government itself and have partly received assistance from the same.*

For instance, the deep tunnel at the Argentiferous silver mine of Tarnowitz in Upper Silesia.

The tunnel at the coal mines of Zabrze and Koenigshuette in the same province.

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The tunnel at the copper and silver mines of Rothenburg and Eisleben in the province of Saxony.

The tunnel at the iron, lead and silver mines of Stahlberg near Müsen.

The tunnel at the iron mines of Eisenzeche and Pfannenberg near Eiserfeld, both the latter in the province of Westfalia.

That at the iron mines Hollerterzug near Herdorf, and

At the coal mines Saarbrücken near Neunkirchen, both in the Rhenish province.

Also, in the kingdom of Saxony the government has constructed a deep tunnel for the silver mines of Freiberg and that of Hanover, for the lead and silver mines at Clausthal in the Harz.

It would therefore also be highly advisable, if the American Government will either construct the Sutro Tunnel or assist the company which undertakes the work.

With especial esteem, yours, respectfully,

DR. H. VON DECHEN,

Actual Privy Councillor of the King of Prussia,
and late Chief of the Mining Department.

LETTER FROM H. KOCH, ESQ., ROYAL PRUSSIAN CHIEF MINING COUNCILLOR.

Clausthal, Nov. 1, 1867.

Mr. Adolph Sutro,

Vienna.

HONORED SIR:

Upon your wish, I repeat the declaration, which I have already made verbally, that the construction of the Sutro Tunnel is a project, based upon sound mining principles, judging from the material, which has come under my notice.

It cannot be doubted, according to all mining experiences, that the mineral bearing character of the lodes near Virginia City will continue downwards at least two thousand feet, at which depth the tunnel will cut the same. Equally

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probable is it, that by means of the tunnel a mining district of high importance will be opened, the working of which will only be made possible by means of the tunnel, and at the possibly smallest expense.

The construction of the tunnel itself offers no difficulties to experienced miners, as has been proven by the Ernst August Tunnel, which was constructed under my superintendence, and which has a total length of three German miles, while yours will only have a length of one mile. But if the rock formation is of that character, as you have described it to me, your task will be proportionably still easier, than has been the case with ours.

After you have reached the lode, it will be best to connect the present existing shafts with the tunnel *by means of borings* for the purpose of draining off the water and in order to facilitate their being sunk to greater depth.

In conclusion, I wish, with all my heart, that your important project will be carried out upon a sound and solid basis.

With greatest esteem,

H. KOCH,

Royal Prussian Chief Mining Councillor.

LETTER FROM BRUNO KERL, PROFESSOR AT THE ROYAL MINING SCHOOL OF BERLIN.

Berlin, November 11, 1867.

Mr. Adolph Sutro,

Paris.

MUCH ESTEEMED SIR:

You had the kindness, at your recent presence in Berlin, to submit to me a pamphlet, "The Sutro Tunnel to the Comstock Lode," etc. I have examined the same with interest, and upon the strength of the facts therein stated, recognize the necessity of the proposed tunnel, if the mining operations on the Comstock Lode are to be made lasting and profitable.

Only by means of such a tunnel—as one has for instance been constructed in the Harz, under the name of Ernst August Tunnel, but under circumstances

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by far more unfavorable than yours—can a metalliferous mountain range be opened properly according to the principles of mining engineering; a well regulated extraction can take place with such a tunnel, and poor ores may be taken out to advantage along with the rich ores, on account of cheap transportation.

This is absolutely necessary, if the durability of a mine is to be secured, while *piratical mining*, the extraction of the best ores alone, will always soon ruin any mine.

It is true, works will be required for the concentration of ores, but their erection will be much facilitated by having the use of the waters issuing from the tunnel. The grand concentration works, which are in the course of construction near Clausthal, in the upper Harz, may serve as a pattern for similar works on account of their simple and practical construction, the results being assured by many experimental tests.

Wishing you the best success in this undertaking,

I am, yours, with a respectful "Glückauf!"

BRUNO KERL.

LETTER FROM C. BORCHERS, CHIEF SURVEYOR OF THE MINES OF THE UPPER HARZ.

Clausthal, November 29, 1867.

Mr. A. Sutro,

Langham Hotel, London.

In reply to your favor of the 21st inst., I beg to state, in accordance with your request, that subterranean surveys, even to carry out the grandest mining works, may be made with great accuracy and reliability.

The very small differences found at the connecting points of the Ernst August Tunnel, the surveys of which were made by me, are as follows, and I must remark, that the principal difficulties in those measurements were occasioned by very deep and inclined shafts, through which they had to be carried out.

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I. ERNST AUGUST TUNNEL.

Designation of Connecting Points.	Length of Measurements by Theodolite, in establishing the levels.	Differences found at the connecting points.		Date when connection was made.
		In Direction.	In Level.	
1.	310 Harz lachters.	0.2 in.	0.15 in.	December 4, 1856.
2.	880 " "	0.3 in.	0.40 in.	December 22, 1857.
3.	2,700 " "	1.5 in.	0.40 in.	January 12, 1859.
4.	2,760 " "	1.0 in.	0.23 in.	March 10, 1860.
5.	1,580 " "	1.5 in.	0.60 in.	April 5, 1861.
6.	1,430 " "	1.1 in.	0.14 in.	April 5, 1861.
7.	1,890 " "	1.5 in.	0.37 in.	June 6, 1863.
8.	3,960 " "	1.2 in.	0.09 in.	October 28, 1863.
9.	1,190 " "	0.7 in.	0.06 in.	June 22, 1864.

The above notes have reference to connections made in a horizontal direction. But by far more difficult are those subterranean surveys in the construction of perpendicular shafts, where work progresses from a number of different levels at the same time, and where the short and the long diameters of the shaft have to meet perpendicularly. The results of such a work, the Queen Mary shaft, on the Burgstädter Lode near Clausthal, the surveys of which were also made by me, are as follows:

At the first connection between the surface and the deep George Tunnel (145 lachters under the surface) a variation from the true perpendicular line was found.

	In the long diameter of:	*In the short diameter of:*
	1.5 inches.	1.0 inches.
At the second connection between the deep George Tunnel and the deep 3d level, 202 lachters under the surface,	1.6 inches	0.0 inches.
At the third connection between the deep 3d and the 6th level, 270 lachters under the surface, ...	0.8 inches	1.4 inches.

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The shaft has consequently been constructed from the different starting points as accurately as if it had been sunk from the surface by a plumb line.

If I have stated above, that subterranean measurements, even for very extensive works may be made with great reliability, I must at the same time *distinctly state*, that I do not make the assertion, that any surveyor, who owns a theodolite or level, would reach such accuracy in his works. I can only affirm, that I have reached the above results by means of contrivances arranged by me, and *by the application of peculiar methods in finding one's position.*

To enter into the details of these, would lead too far, and I may be permitted to remark, that these apparatuses and methods have been described quite in detail in a work which I have written, and the manuscript of which has been lying ready for about a year, on:

"The practical surveys with the theodolite and the air bubble level, with the assistance of proper auxiliary apparatuses, together with an appendix on the application of the magnet, to insure the proper meeting of two subterranean drifts."

All that is required now to insure its publication is, to find a publisher, who will print it under acceptable terms.

Unfortunately this has been impossible to accomplish thus far, for notwithstanding the acknowledged superiority of the work, the public for such is said to be too limited to insure a profitable "bookseller's speculation."

With esteem,

E. BORCHERS.

LETTER FROM THE DIRECTORS OF THE DISCOUNT COMPANY OF BERLIN.

Berlin, October 29, 1867.

Mr. Adolph Sutro, from San Francisco,

Hotel d'Angleterre. Present.

We have read with great interest, the statements concerning the Sutro Tunnel, projected in the State of Nevada, but must reply to your inquiry, that, according to our conviction, there is not the slightest prospect of bringing about a participation of Prussian capitalists in the enterprise in question.

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The capital which finds its way to our inland exchanges, generally steers clear of mining enterprises, and the latter, whenever they promise great profits, are principally taken up by local participation, *while the Government itself takes those enterprises in hand which are of general utility*, and which at the same time go beyond the spirit of private enterprise, for instance, the opening of great salt mines.

Under those circumstances, private capital here will certainly not embark in a distant, foreign mining enterprise, which requires a preparation of years, even if the general interest, connected therewith, and the prospective profits are ever so large.

With esteem,

The Direction of the Discount Company.

A. HANSEMANN,
GOLDSCHMIDT.

LETTER FROM M. BRAUN, CHIEF ENGINEER AT THE ZINC MINES OF VIEILLE MONTAGNE, NEAR AIX LA CHAPELLE.

Moresnet, October 14, 1867.

Adolph Sutro, Esq.

Paris.

MY DEAR SIR:

I have read with great interest the different pamphlets and memoirs on the project of a large draining tunnel in Nevada, which you gave me, and I can only approve of this enterprise to its whole extent.

I have no doubt either of the immense advantage of the Sutro Tunnel for the whole mining district of the Comstock Lode, or of the profits of the enterprise as such.

In fact, I look upon the execution of the work you propose, as a vital question for all mining in the Washoe mountains, and as well as a lucrative investment of capital.

In the following notes I add some remarks on the details of the execution, and remain, my dear sir,

Yours, most sincerely,

M. BRAUN,
Ingenieur en Chef, etc., etc.

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LETTER FROM MICHEL CHEVALIER, SENATOR OF THE FRENCH EMPIRE AND MEMBER OF THE INSTITUTE.

Paris, 27 *Avenue de l'Imperatrice*, *Nov.* 28, 1867.

M. Adolphus Sutro, *Langham Hotel*, *London*.

MY DEAR SIR:

I have taken a deep interest in the communications you have made me, about a tunnel for draining the Comstock Lode, and for establishing a regular mode of working it.

The project itself appears to me as being quite a practicable one. It is, however, in the style and spirit of the enterprises of the United States citizens. You are the boldest people in the world for useful undertakings. The Comstock Lode, judging from the information you gave me, is one of the richest silver fields, which have ever been discovered in America. During the last few years, a large quantity of information has reached Europe, the result of which is, that this mineral district is not inferior to the Potosi, Guanaxato or Zacatecas.

But to produce the benefits which they are expected to give, those silver mines must be worked after the most advantageous methods indicated by science, and by the most powerful and perfect means.

The working of the Comstock Lode, disorderly as it is, whilst there is no tunnel, seems to be little beneficial in the average, but it would in all probability become very lucrative by the opening of the tunnel.

It is likely, that with the tunnel, the main production of silver for the whole world would be on the Comstock Lode, during a certain period of years. Such a fact could not fail to be a benefit to this part of the country and to the far west, and it would give a great impulse to its wealth and population.

Believe me, dear sir,

Truly, yours,

MICHEL CHEVALIER.

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LETTER FROM A. DAUBRÉE, MEMBER OF THE INSTITUTE, AND INSPECTOR GENERAL OF THE MINES OF FRANCE.

DEPARTMENT OF AGRICULTURE, COMMERCE AND PUBLIC WORKS,

MINES.—*Office of the Inspector General, Rue de Grenelle, St. Germain*, 91.

Paris, November 21, 1867.

Adolph Sutro, Esq.

SIR:

You have honored me by communicating to me your plans and projects in regard to cutting a draining gallery, which will also serve as a means of exploring the Comstock Lode.

I think that the project is worthy of the most serious consideration, and presents itself in the most favorable conditions for success.

Otherwise I wish to refer to what I have said in regard to this subject in my official report, which I have been charged to make on the mineral industry of the universal exhibition of 1867, a report which is at the printers, and about to be published.

Receive, sir, with my best wishes, the assurance of my highest consideration.

A. DAUBRÉE,

Member of the Institute, Inspector General of Mines.

LETTER FROM L. E. RIVOT, PROFESSOR AT THE MINING SCHOOL OF PARIS.

School of Mines.—Laboratory. Paris, September 6, 1867.

Adolph Sutro, Esq., London.

SIR:

I have this morning received the publications and plans, which you had the kindness to send me. I am a little pressed for time this moment, being about to depart for the mines of Sialas, (Lezere,) and have not yet read the pamphlets, but I have examined with great interest the plans of the tunnel you

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projected for the drainage of the Comstock Lode. I can, notwithstanding, form an opinion from the explanation which you have given me, and the various reports which I have received at different times from several of my friends who have visited Nevada.

I am convinced, that the tunnel will cut several lodes, parallel to the Comstock, and containing ores of the same description.

The tunnel will permit the working on a grand and active scale of the Comstock Lode itself to a considerable depth. It is hence quite certain, that this tunnel will secure the greatest facilities for the extraction of incalculable riches. I cannot attempt to give an approximating amount, without having studied the mines on the spot.

I can only renew the remark, which I made to you verbally yesterday, that you will much facilitate the working of the mines, which the tunnel will cut, if at the same time a second parallel tunnel is constructed, a little higher up, say 100 metres at most. You will thereby in a short time, secure ventilation in every one of the lodes, which are cut, and you need not be fearful of the increase of cost.

Will you kindly receive, sir, my thanks for the attention in sending me the plans and information, and receive the assurance of my most distinguished regard. You have my most sincere and ardent wishes, that you may soon succeed in an enterprise, which will give a lively impulse to the working of the silver mines of Nevada.

Yours, respectfully,

L. E. RIVOT.

LETTER FROM BARON PRISSE.

St. Nicolas, Belgium, November 24, 1867.

Adolph Sutro, Esq. Langham Hotel, London.

SIR:

I comply all the more readily with your request to give my opinion about your projected tunnel to the mines of the Comstock Lode, since that opinion is entirely favorable to your project.

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The examination of the documents, which you had the kindness to give me, when you passed through Liége, has convinced me, that nothing could contribute so much to the increase and success of the mines on the Comstock Lode, than the prompt and thorough construction of your tunnel.

This is not merely a speculative opinion, which I express, but the work on the tunnel at the coal mines of Hazard, near Liége, which I had the good fortune to have you visit, prove to you, that we carry out, on a reduced scale, what you have so judiciously projected—in fact, in order not to be compelled to pump out to the surface the water from a single coal mine at a depth of 170 metres, and in order to have a basis of extraction favorably located, we have undertaken, and now prosecute for several years a tunnel, which, when finished, will have a length of over 3,000 metres; I congratulate myself as a trustee, for having taken part in this work; it is with a sense of conviction, that I congratulate you upon your well planned project, and wish, with all my heart, that you may be enabled to carry it out.

I am not entirely informed in regard to what might be accomplished in Belgium with industrial enterprises; still I believe it to be very difficult to bring such important amounts of capital together here, as are required for your enterprise; a brilliant future seems to be assured to this enterprise, the dividends must be considerable, but Nevada is far off, and above all, entirely foreign to our established commercial relations.

The construction of your tunnel is of such importance for the development and exploration of the mines already known, and for the general examination of a country, in which it must be expected that new lodes will be discovered, that it appears evident that there is more than a local interest comprised. According to my views, the general interest is so much involved, *that the Government should effectually assist you* by a guarantee of interest on the capital invested, until the completion of the tunnel, and which would no doubt be of great help towards the formation of a company with sufficient capital.

I shall be much rejoiced over every thing, that I may learn favorable to your enterprise, wish you good success, and present to you, sir, the expression

Of my distinguished regards.

WM. L. PRISSE.

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LETTER FROM SIR ROD. I. MURCHISON BARONET, PROF. WARINGTON W. SMYTH, AND PROF. AND. RAMSAY.

Royal School of Mines, London, November 29, 1867.

Assuming the correctness of the data, contained in the reports of Baron von Richthofen and Mr. A. Sutro, and knowing the various advantages bestowed on a mining district by a deep gallery of drainage and exploration, we think the proposed adit or tunnel likely to be of great service to the State of Nevada.

ROD. C. MURCHISON,
WARINGTON W. SMYTH,
AND. RAMSAY.

LETTER FROM P. RITTER VON RITTINGER, COUNCILLOR IN THE MINING DEPARTMENT OF THE IMPERIAL AUSTRIAN MINISTRY OF FINANCE.

Vienna, Nov. 7, 1867.

Mr. A. Sutro,
Present.

The tunnel projected by you for the drainage and exploration of the Comstock lode will, independently of the well known and generally acknowledged mining advantages, possess the special one, that the water which at present is pumped out of the mines by means of numerous steam-engines in a most expensive manner, would in the future not only give no further trouble, but on the contrary could be turned to account with very good results.

By means of this water, large concentration works may be placed near the mouth of the proposed tunnel for the cheap concentration, by mechanical means, of the *many poor ores* which either are thrown aside now, or remain entirely untouched in the mines; the cheap transportation of these ores through the tunnel and the use of water-power instead of costly steam engines will much facilitate these operations.

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I wish therefore, sincerely, that you may soon succeed in getting many participants in this promising enterprise, and that it may soon be carried out.

With especial esteem, yours,

P. von RITTINGER,

Letter from J. H. Stametz & Co., Bankers, Vienna.

Vienna, November 11th, 1867.

Adolph Sutro, Esq.

Dear Sir:

We have read with great attention your statement concerning the grand and useful enterprise of drainage you intend carrying on in the State of Nevada; we feel sorry however not to be able to give you any support in this matter, which we surely should have done particularly on account of the recommendation of our highly esteemed friends, Messrs. Duncan Sherman & Co., of New York.

You will have had no doubt already occasion enough to find that the monetary market in Austria is not so favorable as you have supposed, when you directed your steps to this country in order to raise funds for your enterprise.

Austria is not a monetary country, and the low rate of discount ought not to be considered as an indication of her monetary abundance. The high premium still quoted for gold and silver would have paralyzed, even under more favorable circumstances, all your efforts to obtain the funds you require; we now quote silver 21 per cent. premium.

We feel rather surprised however, that the Government of the United States or that of your State does not bestow more attention on this matter of public welfare. Your plan, if it had to be carried on in Austria, would have found the most efficient support from our government; the matters of public utility as railways, canals, drainage, are always and even now in spite of the bad state of the finances, conducted or at least assisted by our government.

We remain, dear sir, your obed't servants,

J. H. STAMETZ & CO.

Successors.

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LETTER FROM BARON OTTO VON HINGENAU, DR. OF LAW, COUNCILLOR AND MEMBER OF THE IMPERIAL AUSTRIAN MINISTRY OF FINANCE.

Vienna, November 12, 1867.

A. Sutro, Esq.

Hotel Munsch. Present.

REMARKS ON THE SUTRO TUNNEL, NEVADA, U. S. A.

In compliance with the request of Mr. Sutro I have examined the different publications submitted to me by him, concerning the project to accomplish the drainage and exploration of the Comstock Lode in Nevada by a main and district tunnel, have compared the same with previous geological and mining information about the Comstock Lode, and believe to be enabled to report on the same with reference to similar undertakings in European mining districts, as follows:

The statements made in the report of von Richthofen correspond so minutely with the publications of this gentleman, celebrated by his thorough scientific researches, made some time ago in Dr. A. Petermann's Mittheilungen (Supplement No. 19, 1864) that they should be considered fully as probable, as any conclusions, which could be formed on a geological basis.

The character of other argentiferous lodes in European mining districts, for instance on the Harz in Northern Germany, at Pribram in Bohemia and at Schemnitz in Hungary, which at a depth of 2000 to 2500 feet have not decreased in value, assures us of the same conditions at the Comstock Lode, which, like those quoted above, is said to be a true fissure vein filled from below, and the powerful, and silver bearing character of which has been demonstrated in the upper regions by the results already obtained.

Great depth with its riches of silver, which after what has been said exist according to all probability, may be reached:

a. Either by a system of deep shafts which may be sunk at such points on the ore-bearing lode, and in such position and distance from each other, that they may be connected at different levels, making it possible to pump out the water flowing into the same. The connection of these shafts with each other would

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help to ventilate the mines as well as to conduct the water to the main shafts, from which it would have to be pumped.

b. Or by a tunnel to be driven from the lowest point in the nearest valley, which need not follow the ore-bearing deposit, but may reach it within a certain length and depth, under an outward inclination, allowing the water to flow off from the entire deepest portion and from all parts of the mines, which are connected with the main tunnel.

The first plan, which would be preferred in Europe at such points, where an undulating elevated plain renders the construction of a deep tunnel very difficult, and where the distribution of the ores over a small space makes it advisable to sink shafts to obtain quicker results than could be attained with tunnels of many miles in length and costing much time and money, it seems to me that this plan cannot be carried out to advantage in Nevada, considering the peculiar ownership of mining property and the expense of fuel.

Where the law grants but small claims on single lodes or even branch lodes, and where they have not yet advanced to the modern ideas of French or German legislation, to grant large tracts encompassed by natural or square boundaries, which alone can insure a systematical and regular mode of working the mines, it appears quite impossible, to conquer the depth by a combined system of shafts, entirely independent of the fact that without rich coal fields and their close proximity to the mines, supplies of fire wood (which seem to be entirely wanting in the neighborhood of the Comstock Lode) could not be made to last for any length of time in order to supply the steam engines on the shafts which constantly increase in depth.

The only way therefore to explore, drain and thoroughly work the mines on the Comstock Lode, under the existing circumstances, is by an adit, such as the projected Sutro Tunnel.

With the experiences I have made in mining enterprises I must entirely agree with what Mr. John Day, Surveyor of Lyon county says, in regard to the Sutro Tunnel in his report to S. H. Marlette, Esq., Surveyor General of Nevada, dated Nov. 30, 1865. (Annual Report of the Surveyor General of Nevada for the year 1865, page 57.)

Whether the Sutro Tunnel, before it reaches the Comstock Lode, will cut and develop other ore-bearing lodes, cannot be predicted with absolute certainty, but it is to say the least, probable. For von Richthofen reports that the Comstock

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Lode has several branches which run alongside of it, sometimes converge towards the same, then continue as a body of clay, etc., etc.; in short, it seems that there is not one sharply bounded fissure, but a system of fissures, which constitute the entire powerful lode.

If the main lode therefore is surrounded by accompanying parallel branches, it is probable that the lodes which lie to the eastward, (according to Charles Hoffmann's topographical map, showing the location of the Sutro Tunnel,) such as the Monte Christo Lode, Great Flowery Lode and the intervening lodes do not form single fissures, but have branches; or that parallel lodes occur between them, for we have here, as at Schemnitz in Hungary a mountain cracked by fissures, which may all possibly be of an ore-bearing character, filled from below.

For these reasons such tunnels were in olden times called the "keys of the mountain," and to encourage such works, special privileges were granted by the ancient and modern legislators of Germany and Austria, to be transferred always to the deepest tunnel, which should be constructed, in order to induce those undertaking the work to choose the possibly lowest point.

The usual privileges which were connected therewith, consisted of:

a. The right to appropriate all the ore to the size of the tunnel, even in those claims belonging to other parties.

b. In the right to claim one-seventh or one-ninth of all the ores from all the mines which were drained by the tunnel, from the moment their waters run off through the same.

c. A contribution to the expenses of construction by all the mines, which should be drained or ventilated by the tunnel.

d. Sometimes also a toll for the water carried off through the tunnel.

In the language of the old mining laws, these privileges were called "tunnel rights," and

a. Was called the right of the "tunnel cut."

b. The "tunnel seventh or ninth."

c. The "fourth penny" and

d. The "waterfall money."

Sometimes large tunnels have been constructed by governments, who received back a portion of the outlay by means of the aforequoted rights.

The principal works made by government, are:

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1. The "Ernst August Tunnel" in Hanover for the mines of the Harz. Finished in 1863.

2. The "Joseph I. Tunnel" at Schemnitz, which has often been interrupted and is not yet completed.

3. The "Oclya Tunnel" at Abendbànja in Transylvania, which was not successful, for it was carried to a gold deposit concentrated in a single spot which showed no other bodies.

4. The "Ferdinand Tunnel," which is to be constructed from the valley of the river Gran in Hungary to Kremnitz, and which has been commenced by the government.

5. The great tunnel of "Rotheschoeneberg" at Freiberg in Saxony, for draining the mines of Freiberg.

The tunnels mentioned at 1, 2, 3, 4 and 5 are all longer than the Sutro Tunnel (the "Joseph I. Tunnel "has a length of nearly 11 English miles) *and their slow progress has been caused by the lack of money*, which has frequently interrupted the labors for years. The "Ernst August Tunnel" has been completed quickest of all.

The cost of such a tunnel, with the dimensions of the proposed Sutro Tunnel, without a railroad, would in Austria amount to about 2 to 300,000 dollars per English mile, according to the experiences made in constructing the Joseph I. Tunnel at Schemnitz. In America, with the high prices of labor and fuel for the engines on the four shafts, we must certainly calculate on double the cost, if not more still, although the working capacity of laborers is likely much greater there than here.

According to these figures, which must be very indefinite, having but an imperfect knowledge of the prices in Nevada, the cost of the Sutro Tunnel, with a length of 4 English miles would be (200,000×2)×4=$1,600,000, or (300,000×2)×4=$2,400,000. Strange to say, the sum $1,983,616, given on page 31 of the pamphlet entitled "The Sutro Tunnel to the Comstock Lode," as the estimate of the Chief Engineer, corresponds very nearly with the arithmetical medium of the sums 1,600,000 and 2,400,000. Under the *presupposition* therefore, that the costs in America are not more than double of those paid in Hungary in the construction of the Joseph I. Tunnel, the cost of the Sutro Tunnel (*without* railroads) may be put down at $2,000,000.

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Since the probability is very great that this sum, and even a much greater one would be repaid out of the riches contained in the Comstock Lode, and since the act of Congress of July 25, 1865 (vide the pamphlet "the Sutro Tunnel") compels the payment of contributions by all the mines reached by the Sutro Tunnel, gives mining privileges on both sides of the same and grants some land, the repayment of the costs of construction can be but a question of a few years after completion of the same.

If capital should require still more inducements, a guarantee by the government of an interest of 4 or 5 per cent. on the investment during the time of construction and for 10 years thereafter, would, according to my views, suffice entirely to obtain the necessary sums.

The government would risk but little thereby if the condition is made, that the sums advanced for interest should be repaid after a stated time. A bill of that kind should be about as follows:

Article 1. The Government guarantees to the stockholders of the Sutro Tunnel an interest of four or five per cent. on the cost of $2,000,000 during the time of construction, and for ten years thereafter, so that, should the dividends not amount to four or five per cent., the Government advances the difference.

Article 2. Whenever the income of the Sutro Tunnel Company should exceed four or five per cent., that surplus is to be paid back to the Government, and credited on the advances already made, until the whole sum is repaid, and not until then are the shareholders entitled to any higher dividends.

Article 3. The time of construction is limited to —— years. If the tunnel is not completed by that time, the ten additional years of guarantee are to be shortened accordingly.

Article 4. In the re-payment of the sums advanced for interest, no interest is to be charged, so that the capital advanced by the Government in making the guarantee, is to be considered as a loan to the enterprise, bearing no interest.

I should think, that, with the energy and enterprise of the American people, such a guarantee would suffice to get the capital, which is wanting on the Pacific coast, at the rich money centres of the Atlantic States, for the risk to capitalists would almost disappear; while the Government itself makes a loan, which grows smaller from year to year, and at last ceases, and still rapidly develops the riches of Nevada without making a Government work of it.

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In this manner I think the principle of the greatest possible self-activity is given to the enterprise, while the Government complies with its duty in assisting a truly useful and grand undertaking, without taxing the resources of the country too much, and without weakening the impulse of pushing the enterprise ahead.

OTTO VON HINGENAU,
Dr. of Law, Councillor and Member of the Imperial Austrian Ministry of Finance.

LETTER FROM JOHN DAY, COUNTY SURVEYOR OF LYON COUNTY, NEVADA.

Dayton, Lyon County, Nevada, December 12, 1865.

Adolph Sutro, Esq.

SIR:

Agreeably to your request, I made a reconnoisance of the line of your proposed tunnel to the Comstock Ledge in February last, and in the following month took the field with a competent force, the point selected by yourself, although not so low as another near by, was much better adapted in consequence of having a fall of about one hundred feet in a third of a mile from the mouth of the tunnel, with large area for dumping purposes, and the erection of quartz mills, that can be propelled by the water discharged from the tunnel.

The starting point for the tunnel is designated by planting a large stone about two feet in the ground with a cross cut upon the top, and which is on a level with the surface of the ground, and a mound of stones about two feet high erected over it.

And now commences the line as run with theodolite and chain, the course N. 70°.00 W. (true meridian) ascending gradually at the start, and on nearing what may be termed the first summit, quite abruptly, and descending to William Penn Cañon, where the first shaft is located, and distant from the mouth of the tunnel 4,078.5 feet, altitude above the same 446.09 feet.

Thence continuing on the same course, and rising gradually to the main divide, which is distant from the starting point 7,920.5 feet, with an altitude of 1,453.63 feet.

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Then descending abruptly to a ravine in which shaft number two is located, distant 9,261 feet, and in altitude 985.28 feet.

Thence ascending again, (through the Silver Star Mining District,) and at the distance of 13,325 feet, shaft number three was located, and is 1,440 feet above the tunnel.

Then again to the 2d divide, which is distant 16,069.5 feet, with an altitude of 1,699.29 feet above tunnel.

Thence again to the location of the fourth shaft, being 17,909 feet from the starting place, and in altitude 1,371 feet.

On again to six mile cañon, which is crossed in 19,734 feet, and is 1,482 feet in altitude, thence again ascending through Virginia City until the Savage Works (south of the Gould & Curry) on the Comstock is reached, in a distance of 22,114 feet, and in altitude 1,938 feet from the place of beginning, which is about three and a half miles northerly from Dayton.

I will here add that the different altitudes were correctly ascertained with the level, after the line had been measured, and the location of the different shafts decided upon.

Allow me to congratulate you, sir, for being the projector of this enterprise, its importance to the State is incalculable, and its practicability clearly demonstrated—it is in fact a mining necessity.

Respectfully, yours,

JOHN DAY,
County Surveyor.

LETTER FROM GUIDO KÜSTEL, ESQ., MINING ENGINEER.

San Francisco, January, 1866.

Adolph Sutro, Esq.

DEAR SIR:

The Sutro Tunnel for the purpose of draining the Comstock Lode, is the most important and promising enterprise in the Pacific States, and at the same time vital, an absolute necessity to the future working possibility of the Comstock Ledge.

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We may go on for some time yet with the working of the mines, while difficulties and expenses are constantly increasing, but it will soon be found that the hoisting of ore and pumping of water from a greater depth, not even regarding interruptions in the mines, drifts or shafts, caused by cavings, which may occur in consequence of too much water, especially after the rainy season, will depend on rich ore only.

A permanent continuation of rich rock in all or nearly all claims of the Comstock will be a condition for successful working. This, however, no experienced miner could ever expect. The best mines contain chimneys, pockets, and local deposits of rich ore, followed alternately by poor ore or dead masses, sometimes to a considerable extent. This is a rule to which all mines are subject.

The claim owners and corporations will be compelled to join and form still larger companies, in order to diminish the expenses by united operations in timbering, pumping, managing and so forth, but there is no doubt, that the difficulties caused by water, bad air, costly hoisting and timbering, will become so overwhelming, that in a few years all operations on the Comstock will come to a stand, if your proposed tunnel should fail to come into existence.

The construction of a tunnel like this one in question requires some years of hard work. Every month, delay is certainly a great loss, which will be felt in the future. The sooner you commence so much the better for all. There never will be a more favorable offer to drain the Comstock Lode to a depth of 2,000 feet, without any risk whatever on the part of the claim owners, on the contrary, *nothing but benefit will and must result to the whole of the State of Nevada*, for when the tunnel is finished, not only the incalculable quantity of ore, which fills the fissure of the Comstock can be extracted to a considerable depth below the tunnel, yielding an income for more than a life-time, but the tunnel will secure nearly double the quantity of payrock, of which a great part even at present must remain in the mines on account of too heavy mining and hauling expenses.

There are claims on the Comstock which, with a length of twenty feet only between two levels of 100 feet, would furnish 3,000 tons of ore, assaying from $10 to $15 per ton. Such ore, under present circumstances, cannot be worked. Taking the length and depth of the whole Comstock, considering that rock, at a greater depth, assaying twenty or twenty-five dollars, will be considered too poor to cover all expenses, it can easily be perceived, that millions of dollars

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will be lost forever. This is an absolute loss to the community at large, while your tunnel would enable the proprietors of the Comstock to mine and transport this class of ore through the tunnel direct to Carson river for the purpose of concentration.

The division of the Comstock into numerous independent claims will prove inconsistent with proper mining, when surrounded by numerous adversities and obstacles, which will arise in a greater depth on account of water and its consequences. A union of all claims would meet so many objections, that a similar arrangement must be given *up a priori*, so we are reduced again to the only remedy, the "Sutro Tunnel." The tunnel question is only a question of time—whether it be built now, or when half of the Comstock Companies are ruined, *but the tunnel must be made.*

This undertaking is well secured by a lode containing ore from twenty to fifty feet wide, two and a half miles in length, imbedded in porphyry, a rock most qualified for permanent metallic veins. At the greatest depth of 700 feet the Comstock shows rich rock.

The mines of Schemnitz in Hungary, and at Pribram, Bohemia, can hardly be compared with the Comstock in regard to extent and richness. At more than 3,000 feet depth these mines present good ore, in Pribram even richer than in the upper regions. By comparison with other mines, it is reasonable to suppose, that the Comstock descends deeper than the present generation can follow.

Respectfully, yours,

G. KÜSTEL.

LETTER FROM DR. PHIL. BURKART, ROYAL PRUSSIAN PRIVY MINING COUNCILLOR.

Bonn on the Rhine, December 7, 1867.

Adolph Sutro, Esq.

Washington.

In compliance with your request, I give herewith my views on the general advisability and utility of constructing deep drain tunnels for mines—also my

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opinion in regard to one for the Comstock Lode in Nevada—and my views on the causes which have prevented the construction of a greater number of such tunnels in Mexico, at the same time requesting to be excused, if I have perhaps been a little more circumstantial than you may have expected.

PROGRESS OF CALIFORNIA AND NEVADA.

If we contemplate the present condition of the States of California and Nevada, their flourishing cities and villages, their rapidly developing agriculture and commerce, their industry and their lively traffic upon the highways and railroads, created within a short time—and compare the same with the former condition of these countries, which hardly twenty years ago were, with the exception of a few inhabited towns on the coast of the Pacific ocean, and a few inconsiderable settlements of whites in the interior, inhabited only by savage Indian hordes, we feel astonished at the unexampled, almost marvellous, progress, which the population and its development have made in so short a time.

WHAT CAUSED IT.

The question here forces itself upon the mind, what particular circumstances have caused and been able to accomplish such sudden and extraordinary changes of these conditions, after those countries have, notwithstanding their favorable situation and glorious climate, remained unnoticed and in their abnormal condition during the many years of their possession under a colonial government by Spain and afterwards also under the government of Mexico; and we must conclude that the cause thereof is to be found in the discovery of rich gold fields in California, and valuable silver deposits in Nevada, and in the mining operations, which thereby sprung into existence.

ENCOURAGEMENT BY GOVERNMENT.

But if such a branch of industry may so suddenly revolutionize uninhabited and partly but little productive regions, as is the case in Nevada, and if it is capable of inducing a numerous population to permanent settlement and to the establishment of a well organized commonwealth under a providential government as we find in the States of California, and Nevada, *it must surely be con-*

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sidered one of the first duties of the Government to preserve and encourage such an industrial branch and to assist the same energetically, more especially, when it is intended, as in the present case, to exhume treasures slumbering in the depths of the earth, to apply them to the animation of commerce, industry and agriculture, and thereby to increase the national wealth.

IMPORTANCE OF MINING LEGISLATION.

This principle, as regards mining operations has been recognized and followed as correct by the governments of Europe, for they have taken care to establish special laws, not only for the preservation and development of mining in general *but have favored and assisted in particular the construction of deep drain tunnels.* Spain also, has not left this principle unnoticed in her mining legislation, for her former possessions on the American continent, which remained in force after the declaration of independence in Mexico. In some of the States of North America, laws have been made to regulate and secure the possession of mining property.

Independently of the latter, regulations by law for drainage, are absolutely necessary in a politico-economical view, and for the protection of private interests, especially where extensive mining operations are carried on in single districts, and where the ownership is much divided.

LEGISLATION ON TUNNELS.

For this reason, in the mining legislation of Europe attention has in most cases been bestowed upon this important subject, especially in the "Ordenanzas para la mineria de la nueva España (Madrid 1783.)

The construction of deep tunnels, generally acknowledged as the most judicious and cheapest way of attaining these results, has therein been considered preeminently, and the rights and privileges have been established by law, which are to be granted to the parties undertaking such works, not only by the Government, but also by the proprietors of mines, when they do not themselves construct the work.

ASSISTANCE BY GOVERNMENTS.

In numerous instances, the construction of deep drain tunnels at single mines, or for whole districts, in those European countries where extensive mining opera-

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tions are carried on, *have been considered of such importance and necessity*, in order to preserve and continue mining operations in the interest of the people and the national wealth, that the respective governments, whenever the yield of the mines and the means of the miners were considered insufficient for such extensive undertakings, have carried them out at public expense. They looked upon the advantages to be gained as large and important enough to justify the expenditure of very considerable sums for such draining works.

INSTANCES OF GOVERNMENT ASSISTANCE.

Amongst the more important drain tunnels existing in European mining districts, which have been constructed at *Government expense*, I will only name:

The main Key Tunnel, in the district of Mansfield.

The deep Frederick Tunnel, near Tarnowitz, (2,609¾ lachters=17,315 feet long;) but especially,

The deep George Tunnel, in the Harz, (4,645 lachters long, to the Duke George William shaft,) and

The deep Ernst August Tunnel, which is 300 feet under the mouth of the former, and has a length of 7,600 lachters, also in Saxony,

The Rotheschoneberger Tunnel, (length 6,852 lachters, depth 62 lachters under the level of the Anna Tunnel.)

It may further be remarked, that according to von Herder, (see "The deep tunnel from Meissen," page 4 and 48,) the total length of all drain tunnels constructed at different times in Saxony at government expense, was 130,104 lachters (819,395 English feet,*) and those of the Freiberg district alone, had at the end of the year 1835, a length of 81,364 lachters, (512,430 feet English,†) and have therefore absorbed very considerable amounts of the government funds.

IMPORTANCE OF DRAIN TUNNELS.

In order to point out still further the vast importance of deep drain tunnels in great mining centres, I may state the following:—

Before it was decided to construct those important deep tunnels on the Harz, it was generally believed, that the time could already be foreseen when the existing pumping machinery would not suffice any longer, while its increase was

* 155 Miles. † 97 Miles.

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too costly to be profitable, and without that increase those large mining operations would soon have come to an end.

A branch of industry, which up to that time supported a large population, would thus have gone to ruin, without replacing the loss, and without rendering it possible to prevent the impoverishment of a district, kept in a flourishing state by mining and by the industry depending thereon.

The deep George Tunnel offered the remedy to avoid that danger for the time being. But hardly half a century after its completion, similar fears were again expressed, and it was resolved, in order to remove that danger, to bring in the Ernst August Tunnel from a greater distance, at the expense of the government, which finished it in the year 1864, at an expenditure of a very large amount.

TUNNELS AT FREIBERG.

Similar apprehensions in regard to the undiminished continuance of mining at Freiberg, in Saxony, and the danger of imperiling the prosperity of this portion of the "Erzgebirge," induced the Chief of the Mining Department, von Herder, to elaborate as far back as in the year 1830, a project of a deep tunnel, to be constructed at government expense for draining the mines of the Freiberg district, and which was to be driven from the river Elbe to the Halsbrueckner Lode.

He estimated the value of the silver to be produced from the ores made accessible by the same at three hundred millions of thalers, the length of the tunnel at 11,360 lachters, (79,520 Leipzig feet,) its depth under the Anna Tunnel, 92.72 lachters, and the cost at 3,600,000 thalers.

At the same time he proved that this work would be by far the most judicious, compared to several other projects for introducing water power to propel pumping engines, and considered it his duty to recommend this plan as to the true interest of the miners and the country, by securing to Freiberg another period of brilliant mining operations. Von Herder reviewed the advantages of several shorter tunnels, amongst which the Rotheshoeneberg Tunnel, at an estimated cost of 1,500,000 thalers, but dropped these as less advisable.

Still the project of the deep Meissen Tunnel has not been carried out yet, but its construction is simply postponed to a not far distant day. To secure the immediate protection of mining in Freiberg, the Rotheschoeneberger Tunnel was commenced in the year 1844, at government expense, in place of the former,

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and had been finished up to the end of 1865 to a length of 4,709 lachters, at a cost of nearly one and a half millions of thalers, and its completion may be expected before long.

ADVANTAGES DERIVED FROM TUNNELS.

The facts cited should prove sufficiently, *what importance is placed on the construction of deep drain tunnels* in those German States, where mining is carried on; and rightfully so, for correctly planned, promptly and well constructed drain tunnels, in comparison to machinery for deep mining, offer the most essential advantages to the interest of the mine owners, to the State and to the commonwealth. Because:

1st. They cheapen drainage, compared to the application of machinery;

2d. They permit not only an examination of the country traversed, and discovery of the metalliferous deposit contained therein, but also a rational and regular system of mining.

3d. They facilitate ventilation, transportation and the extraction of ore, therefore decrease the expenses in these operations, and consequently,

4th. Allow the extraction and reduction of poor ores, which otherwise could not be turned to account.

5th. They increase the yield and the profits of the mine owners, and also, what is to be considered particularly:

6th. They make it possible to reach far below the tunnel level by means of the existing machinery, and to extract the ores occurring there at a profit, thereby,

7th. Putting into circulation the gold and silver, which these ores yield, a dead capital, slumbering in the bowels of the earth, increasing the national wealth, and

8th. Secure to the population of the neighborhood the means of subsistence for the whole period that mining operations are thereby lengthened.

WISDOM OF GOVERNMENT AIDING IN THEIR CONSTRUCTION.

In consequence of all this, it must be considered a measure wise and fully justified by the circumstances, if a government, in cases where private resources do not suffice, or are divided too much, favors and assists or even carries out on

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its own account, the construction of a well projected, generally useful, and promising deep tunnel, thereby furthering the general prosperity of commerce, industry and agriculture, and increasing the national welfare.

AID TO MINING ENTERPRISES IN MEXICO.

In the very extensive silver mining operations in Mexico, this principle has also been recognized as correct. and the construction of deep tunnels was regulated by the mining laws (Ordenanzas para la Mineria, Tit. X.,) as the most suitable and cheapest way of attaining drainage, and the rights to be granted to the parties undertaking such works were fixed by the same.

These laws also created a fund in the "Banco de Avio," derived from the duties paid to the crown on the silver produced, which was set apart for the establishment of a mining tribunal and "Colegio de Mineria" as well as for the purpose of making loans in assistance and for the animation of mining enterprises (Ordenanzas, Tit. xvi;) but of the application of funds for the latter purpose but little has become publicly known.

REASONS WHY BUT FEW TUNNELS WERE CONSTRUCTED.

If notwithstanding many mines in Mexico went to ruin on account of lack of capital, and if but few and limited deep drain tunnels have been carried out, the reason therefore must not be sought in the conclusion, that they were considered injudicious or superfluous. A closer examination of the subject, on the contrary, shows that this must, in most instances, be ascribed to the peculiar and special circumstances under which mining operations were carried on in Mexico, and to a total disregard of the common welfare and those considerations, which are of a politico-economical nature. The high plateau of Mexico at the same time prevented their construction in many places; this was especially the case in the districts of Fresnillo, Rancos, Angeles, etc., etc., and in order to prove the former statement the following may be said:

MANNER OF WORKING THE MINES.

1st. Soon after the conquest of Mexico many of the mines were taken possession of, more with the aim of rapidly obtaining and converting into value large

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quantities of rich ore than to carry on well regulated mining operations, which would have required longer time and absorbed more capital in their preparation.

It was therefore preferred to apply the anything but superabundant laboring material to the extraction of ore, rather than to preliminary and elaborate mining operations. This suited the laborers all the better, as by sharing a portion of the ores (partido) larger earnings were obtained, or at least promised to them, than they could have acquired by working in the country rock.

As a general thing, also, it was not within the power of the mine owners to procure the necessary number of workmen, particularly if rich ores were being extracted on neighboring mines, which secured to the miners high wages from the share they held in them.

In addition to this it often happened that a mine was abandoned whenever all the rich ores had been taken out, before new ones were discovered; for the proprietor either did not possess the capital for further operations, or did not care about risking again the profits already made. The water then soon filled the mine and the improvements went to ruin before any one could be found to start work anew. This required large capital for pumping out the water and for making new explorations in order to find good ores, and was generally accomplished by repairing the old shafts, provided they were not too deep, rather than by a tunnel, which the predecessors had neglected to make. In mines of considerable depth, the costs of clearing them from water and putting them in order were quite large, and caused a grievous loss if no new bodies of ore were found as was the case with many mines after the declaration of independence in Mexico.

MINES OWNED BY PERSONS WITHOUT MEANS.

2. The way and manner of acquiring mining property in Mexico, particularly when persons without means made the discovery of rich deposits, is correctly described by St. Clair Duport on page 29 of his work, "De la production des metaux precieux au Mexique," and was partly the cause of preventing the construction of long tunnels during the time of the first stage of mining operations. The means for that purpose did not exist, while the sinking of a shaft and the erection of a horse whim answered the purpose, and were much cheaper.

A desire to improve his momentary financial condition is always decisive to a miner, and we therefore find the results above described.

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PROVISIONS OF THE "ORDENANZAS DE MINERIA."

3. Although the "Ordenanzas de Mineria" give the guardianship over mining operations to government experts, under the general supervision of the "Tribunal de Mineria," the smallest portion only of the regulations made by them were carried out,especially at a distance from the capital; therefore mining operations were only conducted with a regard to private interests, which were not always judged correctly from a want of the necessary mining knowledge by the superintendents.

IGNORANCE OF SURVEYING.

4. The latter, consequently, in many instances could not form any idea of the topography of the country and could not establish the levels indispensable to the construction of a proper tunnel. Prior to the establishment of the mining school in Mexico, properly educated engineers and mining surveyors, who could level off and survey a locality correctly, were to be found in but few mining districts, and people therefore remained in the dark about the advantages of different tunnel routes, which might have been selected.

THE MINES OF ZACATECAS.

All this together and the division of mining property amongst many persons appears to have been the cause, why a deep tunnel, the construction of which is much favored by the topography of the locality was not executed at an early day in the mountains of Zacatecas.

Afterwards when competent companies were formed, owning more extensive mining ground, the mines had already reached a greater depth than could have been obtained by a tunnel of not too great a length, so it was preferred up to a late period, to pump the water through the shafts which are located high up on the mountain, rather than to commence the construction of a deep drain tunnel, although such could have been made even then to good advantage.

FACILITIES FOR THE CONSTRUCTION OF A TUNNEL.

The plain which surrounds the mountain of Zacatecas being situated 900 to 1000 Paris feet (and at some distance still deeper) under the mouth of the shafts

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located on the middle of the mountain, the construction of a tunnel would have obviated the necessity of lifting the water to so great a height. Besides the very considerable advantage would have resulted of exploring the mountain, at the same time of opening up such bodies of ore as had been overlooked, of examining them through side drifts and of employing the existing pumping machinery for clearing those parts of the mines situated under the tunnel level.

About the year 1830 Don Francisco Garcia, then governor of that State was not disinclined, upon my proposition, to construct such a deep tunnel at government expense; it is true he dropped this plan in order to get the mines of Fresnillo started, but came back to the original project and was only prevented from carrying it out by the political circumstances and disorders of the country.

THE MINES OF GUANAJUATO.

The mountains of Guanajuato also offer a very favorable opportunity for the construction of a deep tunnel to draw off the water from the mines located there, which does not seem to have been properly appreciated. The plain spreading out to the southwest, at a moderate distance from the mountain of Guanajuato, is situated, according to barometrical measurements, 700 feet under the town, and 1,400 feet under the top of the shaft of Valenciana, so that, below Marfil a favorable point might have been selected to drain the mines of the Veta Madre, and probably also those of La Luz, by means of a moderately long tunnel. The same would doubtless have cost but little, for it would have traversed, to a large extent, a formation of red conglomerate.

That such a plan was not carried out under the colonial government of Spain, may have been the result of the above mentioned circumstances; why it was also neglected afterwards and not examined into under the administration of the English companies, which had undertaken to work the mines of Guanajuato, can only have been caused by their proportionally short contracts with the mine owners. At the same time I do believe that it would even now be to the interest of the latter, and especially to that of the State government, to pay to this matter the requisite attention, and to establish by an examination, what private and politico-economical advantages would result from the construction of a deep tunnel to Guanajuato.

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TUNNELS EXISTING IN MEXICO.

In such places in Mexico, where the favorable topographical features of districts containing silver lodes could be recognized without intricate measurements and mappings, and where short tunnels could therefore be constructed without difficulty, they have often been made, as we may observe in numerous places.

Thus we find tunnels, and some of not inconsiderable length, at Tasco, Tlalpujahua, Real del Monte, Lomo del Toro, San José el Oro, Guadalcazar, Catorze, etc., etc. The number of tunnels at Tlalpujahua from the valley to the two main lodes, is so great that their aggregate length would have sufficed for a main tunnel of not inconsiderable depth. This great number of tunnels was constructed, because the mines situated on one and the same lode, did not adopt a joint working system, for each mine owner, unconcerned of his neighbor, only strove to get rid of the water in his own mine, and to transport his ore on the shortest road to the valley.

The only tunnel, which has a greater length, is that to the Coronas Lode below Tlalpujahua, but even this was neither continued at right angles to the mines situated further off from the hanging wall, nor were branches constructed to those mines, located further south and higher up in the mountain.

ABANDONMENT OF THE MINES.

The mines in the places mentioned, soon reached considerable depth under their respective tunnels, and were abandoned under the increased cost of mining, and that of pumping, after the rich bodies of ore had been taken out, or whenever they became poorer.

The shafts, galleries and underground works then went to ruin, and to re-work such mines was much more difficult and expensive than would have been the case had the water been drained off regularly by means of a deep adit.

In such condition were the mines of Tlalpujahua, when in the year 1825 an English company attempted to place them in working order again. Without the slightest possible knowledge of the abandoned ore deposits, and the condition of the lodes, large sums had to be expended in order to obtain that knowledge. Through my instrumentality a deep tunnel was commenced, which with a length of 5,500 varas would have given a depth of 328 varas at one of the

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principal shafts, but work upon the same was soon again stopped on account of a lack of profitable ore, and the refusal of the shareholders to pay any further assessments.

REAL DEL MONTE.

Amongst the Mexican mines, with which I have become acquainted, Real del Monte can show the longest tunnels, but is also much favored by its situation on a mountain range not very wide, which is bounded on the south by the high plateau of the valley of Mexico, and on the north by that of Ototonilco.

Already in the first half of the last century, a deep tunnel was commenced on the south side of this mountain range near Azoyatla, and during nine years constructed at a cost of $80,000 to a length of 1,200 varas; it was then discontinued under the pretext of bad air and hard rock, but probably on account of its high location. Another tunnel was commenced at Omitlan to the northward of Real del Monte, but this also was discontinued after one year.

But when a grant had been made to the mine owners of Real del Monte, securing to them a larger field of operations, they commenced another deep tunnel in the year 1749, near the mine of Moran, which reached the Biscanya vein already in 1762, having a length of 2,881 varas, and a depth of 203 varas at the Toya shaft. Through this tunnel more than seven millions of dollars were taken out in a short time; it secured to the owners the profitable extraction of much silver ore, and made it possible to work the mines, though later, with changing success, until the troubles commenced, caused by the declaration of independence.

However, before that time, still another deep tunnel, el "Aviadero," had been commenced near Omitlan, which, at a length of 4,500 varas, was to cut under the upper tunnel at a depth of 130 varas, but was stopped at the same time the mines were, before much of it was finished.

ERRORS OF AN ENGLISH COMPANY.

At Real del Monte, an English company, in re-commencing operations on these mines in 1825, committed the error not to properly appreciate the necessity of completing this tunnel, and to attempt the drainage of the mines by steam engines alone. They did not consider that the water would have to be pumped 130 varas less in height, that the pumping would be less costly, and

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that furthermore it would be possible to go that much deeper on the lode, and make more silver ores available.

But, when in 1847 it was barely possible to raise the accumulating water to the upper tunnel by means of powerful steam engines at an annual cost of $90,000, and after extensive bodies of rich ores had been taken out without any profit to the stockholders, the mines passed over into other hands. The new owners paid more attention to the Aviadero Tunnel, fully appreciated its object, and decided upon its continuation, so that the same had advanced in the year 1859, through very hard rock, to a length of 2,403 varas, and was still being pushed ahead in 1862.

When this tunnel reaches the Biscaina Lode, another good time may commence for the miners of Real del Monte, but the great loss will be difficult to make up, which the former company, as well as the present one sustained by the non-construction of the tunnel, and by the consequent necessity during many years, of keeping the mines clear of water by very expensive steam engines.

Catorze can also show several tunnels, amongst them two of not inconsiderable length, but which seem to have been commenced more with a view of facilitating the transportation of ore than to drain off the water, and which were not completed when I was in Catorze.

GENERAL LOSSES FROM THE WANT OF TUNNELS.

The losses occasioned in Mexico by neglecting the timely construction of deep tunnels cannot be given in figures, but the amount lost by private persons and by the nation must have been considerable, to judge from what has been stated already.

The high expenses for pumping, those for exploration, preparation and transportation, but especially the fact that ores had to be left behind in the mines which could have been extracted to advantage under a rational system of mining, occasioned a very serious loss, which it is much to be regretted, in a politico-economical view, was not avoided by proper assistance from the Government.

THE SUTRO TUNNEL.

In conclusion, I will not fail to express my views on the Sutro Tunnel or deep adit for the drainage of the rich Comstock Lode; but not having that know-

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ledge acquired from my own observations and examinations I must base my remarks on the valuable detailed accounts of the locality, given by von Richthofen, J. Ross Browne and R. H. Stretch, in regard to the topography of the neighborhood and the lode itself, and in regard to the mining results.

According to these accounts the Comstock must be considered the richest of all known silver lodes. Notwithstanding, the lode is not ore-bearing in all places and not equally rich, but shows, as is also the case with all silver lodes of Mexico, richer and poorer ores, which are interrupted horizontally and perpendicularly by poor spots, that is by matter which fills the vein containing no ore. The statements about the explorations thus far made, show a greater extent of ore in depth than in a horizontal direction.

The bodies of ore, also show a certain dip, not with the inclination of the lode, but they are found either further north or south in the lower levels than in those nearer to the surface; additional explorations are necessary however in order to base thereupon a systematical working of the mines.

MINING OPERATIONS ON THE COMSTOCK LODE.

The lode is known to a length of 24,000 feet, and more than 40 proprietors or companies exist with as many different claims of from 10 to 2,000 feet in length, who have constructed several shallow tunnels and have sunk numerous shafts, thereby sacrificing more money than would have been necessary for regular mining operations.

On these shafts are 47 steam engines of about 2,000 horse power, of which 8 are used for pumping alone, 13 for hoisting and 26 for both purposes, which occasion unproportionally great expenses with the high prices of fuel.

The deepest portion of the Chollar Potosi mine has reached 923 feet under the croppings near the top of the shaft and is 909 feet above the level of the Sutro Tunnel, while the lowest works of the Gould and Curry at a depth of 900 feet are only 900 feet, and those of the Belcher at a depth of 850 feet are but 750 feet above the Sutro Tunnel, the latter mine therefore having the greatest absolute depth.

Several other mines have not advanced so far, the White and Murphy being still 1,585 feet above the tunnel level, offering therefore a much larger unexamined field for exploration than the others.

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YIELD AND PROFITS OF THE MINES.

The Comstock Lode has, according to the statements given by Browne, yielded from 1859 to 1866 gold and silver bullion, valued at $66,000,000, of which $16,500,000 were extracted in 1866. A like produce is expected for 1867 and for some years to come, and the remark is made, that it might even be increased to $20,000,000. These amounts have been furnished from 1859 to 1866 by the different claims or mines, in a very unequal and changing proportion, for some had very rich ores, some poor ones, and others none at all.

Equally different were the profits of the different mines, which were regulated somewhat by the expenses, but some single proprietors are said to have cleared $30,000 per annum, and even more. Some mines however, are not yielding as much as they did, partly because pumping with steam engines is too expensive, partly because the existing power does not suffice to go any deeper, or because other difficulties have arisen, and lastly, also because the capital is wanting to carry on the necessary explorations.

INCREASING EXPENSES OF MINING.

But the expenses of mining increase with increasing depth of the works, and it can therefore not appear strange when it is stated that in many mines on the Comstock Lode they now either absorb the yield partly, or entirely, considering the high wages and high prices of materials. Nor can it appear strange that even rich bodies of ore do not cover the expenses in the limited extent of small claims on account of the dip of the ore, and of the expenses occasioned by the necessary preparatory works, such as shafts and galleries and those of pumping, ventilation, extraction, etc., etc.

The expensive system of mining on the Comstock Lode is shown by the statement of Browne, that the length of tunnels, galleries, shafts and connections already made, is 40 miles, which must seem very great, considering the small depth and limited extent of the works in most of the mines.

All this kind of work and in fact all sorts of labor are done at very high prices, and we find it stated that with a yield of $16,500,000 in 1866 the profits hardly amounted to $500,000.

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A DEEP TUNNEL THE ONLY REMEDY.

The evil of an increase of cost by increasing depth, and the consequent interruption of mining can, under existing circumstances, be met only by a deep tunnel and a joint system of rational mining, which will make steam engines superfluous.

The Comstock Lode being cut up into many different claims, the construction of a tunnel with its north and south branches is only possible, if third parties undertake the work.

In that way alone, it seems to me, will it be possible to diminish the present high cost of mining, of opening up the bodies of ore with the smallest possible expense, and of making poor ores available, which now remain in the mines and which afterwards could never be reached again.

The Sutro Tunnel will furthermore have the advantage of exploring the whole country from its mouth to the Comstock Lode, a distance of 20,000 feet, in which several paying silver lodes are known to exist, of opening up the same and of facilitating the examination of these lodes.

Under such circumstances I can only concur in the opinion of those experts, who have expressed themselves in favor of this tunnel, and I may warmly recommend its construction as not only in the interest of the mine owners, but also in that of the Government.

I close with the hope that you may soon be able to inform me of your success in having removed the last obstacles to the execution of this project, and that you have insured and commenced the construction of the tunnel.

BURKART, Dr. Phil.,
Royal Prussian Privy Mining Councillor.

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REPORT

OF THE

Committee on Federal Relations,

OF THE

NEVADA LEGISLATURE,

ADOPTED UNANIMOUSLY, JANUARY 23, 1867.

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REPORT.

The Committee on Federal Relations, to whom was referred "Joint Memorial and Resolutions asking Government aid in the construction of the Sutro Tunnel," beg to report the same back and recommend its passage.

Along with said Memorial, and as a part thereof, they likewise submit the following report :

EXTENT OF THE MINING REGIONS.

The vast regions embracing portions of California, Nevada, Dakota, Nebraska, Colorado, New Mexico, Arizona, Utah, Washington, Oregon, Idaho and Montana—covering an area of one million square miles, containing untold wealth in gold and silver mines—to-day command the attention of the American statesman.

GOLD MINING IN CALIFORNIA.

Mining for gold and silver is comparatively of recent date within this country. The discovery of gold in California gave the first active impulse to the search for precious metals. The immense *placers* of that region invited a numerous and adventurous population from all parts of the globe ; and the facility with which the surface earth yielded its golden treasures—the implements required consisting only of a pick, a shovel, and a rocker, within the reach of every one—soon swelled the amount of bullion produced to astounding figures, and worked a revolution in the financial condition of the entire world.

PLACER MINING NOT PERMANENT.

But the gold distributed in the alluvial deposits, attacked as it was by many thousands of miners, soon disappeared in the most favored localities. The enterprising mining population looked for more permanent deposits, and discovered them at some depth upon the bed rock, where ancient rivers had deposited the precious particles.

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These also gave no promise of permanency; and the intelligent miner now turned his attention to the *fountain head, the true matrix of the precious metals, from whence the immense distribution had taken place, which covers the hill-sides and valleys—the quartz mines of the country.*

THE COMSTOCK LODE.

The discovery of the Comstock Lode in the then Territory of Utah, on which are located the most productive mines at present wrought in the world, gave a new impulse to quartz mining.

This remarkable mineral deposit occurs in what is termed a true fissure vein, or a vein formed at a very remote period by some great volcanic convulsion, causing the crust of the earth to be rent in twain, thus creating an immense chasm or fissure, several hundred feet in width, and several miles in length.

CONTINUITY IN DEPTH.

This large fissure, which gradually filled up by ascending vapors and gases, carrying with them a volatile form quartz and gold and silver, leaves no doubt, to the scientific investigator, of its permanency; for the very theory of its formation, having been filled from unknown depths, compared with which the deepest mining works appear insignificant, proves it conclusively.

Independently of theory, however, practical experience has shown all over the world, that true fissure veins are continuous in depth; and not a single authenticated instance is recorded where one of them has failed. Notwithstanding, mining is looked upon as a hazardous undertaking; and no matter what theories demonstrate, or what experience in other countries teaches, capital is reluctantly invested in adventures of that kind.

As stated already, quartz lodes are the true source of the precious metals: to them must we look for the future supply, *and anything which tends to develop that interest, should be regarded by the legislators of the country as an all-important benefit to the nation.*

THE SUTRO TUNNEL.

What is required to thoroughly develop that interest, and to induce private capital hereafter to embark largely in mining pursuits, is a practical and positive

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demonstration of the continuity of the mineral lodes in depth; and no work will prove this proposition more thoroughly and satisfactorily than the proposed Sutro Tunnel. This tunnel, starting near the borders of Carson river, a distance of four miles, will cut the Comstock Lode at a depth of 2,000 feet; while, if continued a short distance, it will reach a point under the summit of Mount Davidson at a depth of 3,500 feet. By means of the tunnel, the mines can be worked at least one thousand feet below its level, thus demonstrating the continuance of the Comstock Lode to a depth of 3,000 feet—a greater depth than has yet been reached in any mine in the world.

IMPORTANCE OF THE WORK.

The bearing this work will exercise upon the future of the mining interest in the United States cannot be too highly appreciated. Capital will be invested in enterprises of the like character where no confidence exists now; millions of treasure will see the light, which now lie buried deeply in the bowels of our mountain ranges. The immediate and direct result from this work, will be the developments made on the Comstock Lode. This great lode was discovered in the year 1859, and has yielded thus far $64,000,000 in silver and gold—chiefly the former. The regular annual yield, now, is $16,000,000.

OTHER LODES.

If we compare this lode with other great mineral lodes, we find that none were ever worked in the old world of equal or approaching magnitude. The American continent has produced three similar mines—the great Potosi mine of Bolivia, which yielded $1,200,000,000, the Véta Madre of Guyanajuato, $800,000,000, and the Véta Grande of Zecatecas, $650,000,000—the two last named being in Mexico. Competent geologists assert that the Comstock is a larger, more regular and permanent vein than either of the others mentioned. What can we expect to be its yield, with the proposed tunnel once finished, enabling the miner to explore the same to a depth of three thousand feet, with the modern improved appliances for mining, and the enterprise and energy of the American artisan to guide its operations?

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FUTURE YIELD.

If we estimate its yield, after the proposed tunnel is completed, at $30,000,000 per annum, *we shall have, in thirty years, the enormous yield of* $900,000,000; and this may be considered a moderate estimate. Without the projected tunnel, this vast and important property, which directly and indirectly gives employment to nearly or quite 100,000 people, will, after the lapse of a few years have to be abandoned, for reasons which are at once apparent and conclusive.

DIFFICULTIES IN MINING.

The yield of these mines for the year ending December 31st, 1866, has been $16,000,000, which was procured at a cost to the mining companies of $15,500,000, leaving the paltry net profit of $500,000. This extraordinary result is due to various causes, prominent amongst which are, the difficulty of removing the water from the mines, want of ventilation, the increase of heat in going downwards, and the expense of transportation. These mines are situated on the side of a mountain, and are approached by perpendicular shafts, of which there are over forty. These have reached a depth of from 500 to 900 feet, and on each of them a steam engine is placed, which propels pumps, and at the same time hoists the ore and *débris*. The cost of fuel at Virginia City and Gold Hill, where these shafts are located, is sixteen dollars per cord, in gold; and the consumption of fuel is so great, that this item alone absorbs a large share of the yield, and that item of expenditure increases for every foot of descent. These engines are kept in motion day and night; for were they allowed to stop, the mine would fill with water.

INCREASE OF HEAT.

Another serious obstacle, as depth increases, is the difficulty of keeping the mines supplied with a sufficiency of fresh air to furnish the oxygen required for respiration. The increase of heat, which amounts to one degree of Fahrenheit for every sixty feet in depth, prevents the miner from performing the same amount of work as if he were employed in a healthy atmosphere, and at a moderate temperature. The pecuniary loss from this source is very large, considering that 3,000 persons are employed at an average pay of three dollars

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and fifty cents, in gold, per day of eight working hours. This loss is estimated at twenty-five per cent.

EVIL EFFECTS OF FOUL AIR.

But a consideration of a still graver character, is the evil effect a foul atmosphere exercises upon the health of the miner. Amadee Burat, an eminent French writer, says upon this subject:

"The circulation of fresh air is one of the most important in mining. This importance may be readily understood when we find that four-fifths of all workmen who perish in mines, are victims of foul air."

Scoffern, an English writer, makes use of the following language:

"The stagnant air acts on the organs of respiration, producing consumption and other allied diseases, which carry off the miner in the prime of life. As a class, they are robust and naturally less liable than even seamen to such diseases; but such are the pernicious effects of the impure air they breathe, that fifty-two per cent. die of consumption, in a country where the per centage amongst agricultural and other surface laborers amounts only to twenty per cent. in the worst localities." *The cause of humanity should provide a remedy, when an effectual one is within reach!*

Many other difficulties present themselves in deep mining, which increase in a fearful ratio as depth increases; and the profits, which have already dwindled down to a small amount, soon thereafter will be absorbed entirely, and then be exceeded by the cost of mining.

The fate of these mines, if no remedy is found, is therefore clearly foreshadowed.

NECESSITY OF A TUNNEL.

The only remedy, positive and sure in its operation, which presents itself, is, the construction of a deep adit or tunnel. It will cut the mines at a depth of 2,000 feet, draining off the water to that depth by its natural flow, securing the best ventilation, cooling the atmosphere in the mine, furnishing facilities for transportation, and making it possible to dispense with all pumping and hoisting machinery: for the miner can enter the mines from below, work upwards, and the ore will fall by its own gravity; whilst a railroad in the tunnel will transport the same at small cost to the adjacent valley.

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Such are some of the considerations which present themselves, and which show *that the proposed work is a matter of vital importance, and one of absolute necessity to the State of Nevada.*

MINING COMPANIES.

The mining companies, which are mostly incorporated in California, and the stock owned to a large extent in San Francisco, are unfortunately mainly controlled by a class of men who speculate from day to day upon the varying fortunes of the mines, and only care to increase the momentary price of the shares. Their interest in the permanent yield is but small; and this cause, together with the present financial condition of most of the companies, give little hope of substantial aid from that source.

EUROPEAN MINES.

Whilst we are enriching the whole nation by the production of large amounts of bullion, we are ourselves growing poorer from day to day. In all European mining countries, the respective Governments, with an eye to the importance of the production of bullion, and to promote the general welfare of the population, have given substantial and liberal aid to similar undertakings—a number of which, on a much larger scale than the one here proposed, have been successfully carried out, and the future of their mines secured. A tunnel was lately finished in Hanover, fourteen miles in length; one in Saxony is nearly completed, eight miles in length; and another in Austria of equal length.

Your Committee now desires to call attention to the important bearing the increased production of bullion will exercise upon the financial condition of the country, and in the payment of the national debt.

DEPRECIATION IN THE VALUE OF MONEY.

The world's stock of coin in the year 1848 was, in round numbers, eighteen hundred millions of dollars; to this has been added to the present time an equal amount, of which the United States have furnished, according to Secretary McCulloch's late Report, eleven hundred millions. Allowing two thousand millions as the natural increase of taxable property by the growth of the country, we still find that the same has doubled in the United States, within the period

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named. From seven thousand millions it has increased to sixteen thousand millions. This result is due, not to a direct depreciation of the precious metals, for that is regulated by the standard adopted by our Government, but by an increase in value of all property and commodities. Thus, the same article that could have been bought eighteen years ago for one silver dollar, now requires two; or, in other words, two silver dollars at the present time only have the intrinsic value of what one then had.

DIFFERENCE BETWEEN THE PRECIOUS METALS AND OTHER COMMODITIES.

It must be borne in mind that there is a vast difference *between the production of gold and silver and all other productions.* Most of the latter are articles of consumption; they are useful for a special purpose, in the application of which they are consumed, disappear, and cease to exist. The farmer who produces wheat to the value of $1,000, and the miner who digs out gold to that amount, may derive an equal profit from their different pursuits; and hence one stands on an equality with the other, so far as individual gain, or the interest of a particular locality, is concerned; yet wheat is ground into flour, made into bread, and consumed, while the gold dug out by the miner finds its way into the channels of trade, is transferred from one nation to another, as the balance of trade may require, *and forms a permanent addition to the stock of the precious metals in the world.*

INCREASE IN QUANTITY OF THE PRECIOUS METALS.

At the time of the discovery of America, in 1492, the stock of the precious metals in Europe was estimated at $170,000,000. In the year 1600, it had increased to $650,000,000—a gain of nearly fourfold.

That extraordinary addition to the precious metals in a little more than one hundred years, had a corresponding effect. Gold and silver became cheaper in the same ratio as their quantity had increased. It required four times the amount to buy any commodity—that is to say, all commodities increased in price fourfold. The same increase in prices can be traced distinctly to the present day, as the stock of the precious metals gradually increased, while making due allowance for all other causes which would exercise a bearing in that direction, such as the increase of commerce, the growth of population, facilities for intercourse between different nations, etc., etc.

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APPRECIATION IN VALUE OF PROPERTY.

The conclusion we arrive at, by carefully examining into this subject, which is clear and positive, is that the increase in quantity of the precious metals *de*preciates their value in precisely the same proportion as it *ap*preciates the value of all kinds of property. Or, in other words, the per centage added to the stock of the precious metals in circulation, adds the same per centage to the money value of all property in the world.

Francis Bowen, the best American authority on political economy, expresses this view in the following words:

"The general principle is, that the value of money falls in precisely the same ratio in which its quantity is increased. If the whole money in circulation should be doubled, prices would be doubled; if it was only increased one-fourth, prices would rise one-fourth."

The same principle is laid down by John Stuart Mill, well known as the highest modern authority in England. He says:

"It is to be remarked that this ratio would be precisely that in which the quantity of money had been increased. If the whole money in circulation was doubled, prices would be doubled; if it was only increased one-fourth, prices would increase one-fourth."

INCREASE OF TAXABLE PROPERTY IN THE WORLD.

To illustrate the immense bearing this rise in prices exercises all over the world, we will assume the following figures:

Taking the taxable property of the whole civilized world at $200,000,000,000, the amount of money in existence at $3,600,000,000, the addition of $900,000,000 would depreciate the precious metals 25 per cent., and, in consequence, it would require $250,000,000,000 to purchase all the taxable property of the world. The addition of $900,000,000 in money, therefore, would have the effect of producing $50,000,000,000 in the increased value of property. Every addition of $100,000,000 has its corresponding influence on the increased value of all property: it adds over $5,000,000,000 to the property of the world. This increase of value may not be perceptible from year to year; the aggregate result however, after a number of years, is inevitable. Bowen refers to this as follows:

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"There may be brief and violent fluctuations in the relative value of particular commodities, while the great movement is steadily going on which slowly enhances the value of all."

IT DOES NOT AFFECT INDIVIDUALS.

This increase in value, however, does not materially affect individuals: for when the cost of living increases, the rates of wages do, also; *but it acts as a stimulus to enterprise, and thus creates general prosperity.*

Hume, long ago, remarked that, "in every kingdom into which money begins to flow in greater abundance than formerly, everything takes a new face: labor and industry gain life, the merchant becomes more enterprising, the manufacturer more diligent and skillful, and even the farmer follows his plow with greater alacrity and attention. But when gold and silver are diminishing, the workman has not the same employment from the manufacturer and merchant, though he pays the same price for everything in the market; the farmer cannot dispose of his corn and cattle, though he must pay the same rent to his landlord. The poverty, beggary, and sloth that must ensue, are easily foreseen."

Even so cautious and conservative a writer as the distinguished English political economist, McCulloch, fully admits the truth of this view, though he adds the just qualification that the fall in money must proceed from natural causes.

William Jacob, in his valuable treatise on the precious metals, remarks:

"The world is very little really richer or poorer from the portion of metallic wealth that may be distributed over its surface; the whole mass of material wealth is neither diminished nor increased by any change in the relative weight of gold and silver to the usual measures of other commodities. The only benefit to the world in general, from the increase of those metals, is that it acts as a stimulus to industry by that general rise of money prices which it exhibits to the view. It matters little to him who raises a bushel of wheat whether it is exchanged for a pennyweight or an ounce of silver, provided it will procure for him the same quantity of cloth, shoes, liquors, furniture, or other necessaries which may be desirable to him."

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IT MATERIALLY AFFECTS AN EXISTING DEBT.

But when a debt already exists, being a fixed number of dollars, the decrease of value of each dollar reduces the debt in the same proportion. The immortal and much lamented LINCOLN thoroughly understood this question, when, in his annual message of 1862, he made use of the following language:

"The immense mineral resources of some of those Territories ought to be developed as rapidly as possible. Every step in that direction would have a tendency to improve the resources of the Government and diminish the burdens of the people. *It is worthy of your serious consideration whether some extraordinary measures to promote that end cannot be adopted.*"

That wise and good man had carefully studied the effect which was then strongly felt in Europe, and which is alluded to by Alison, the English historian, as follows:

BENEFICIAL INFLUENCE IN GREAT BRITAIN.

"It will belong to a succeeding historian to narrate the wonderful spring which this country (England) made during the five years which followed 1852, under the influence of the gold discoveries in America and Australia. The annual supply of gold and silver for the use of the world was, by these discoveries, suddenly increased from an average of ten millions to thirty-five millions pounds sterling. Most of all did Great Britain and Ireland experience the wonderful effects of this great addition to the circulating medium of the globe. Prices rapidly rose, wages advanced in a similar proportion, exports and imports enormously increased, while crime and misery rapidly diminished. Wheat rose from forty-five to sixty-five shillings, but the wages of labor of every kind advanced in nearly as great a proportion: they were found to be about 30 per cent. higher than they had been five years before. In Ireland, the change was still greater, and probably unequalled in so short a time in the annals of history. The effect of the immense addition to the currency of the world, to the industry of all nations, and in an especial manner of the British Isles, has been prodigious. It has raised our exports from £58,000,000 in 1851 to £97,000,000 in 1854, £95,000,000 in 1855, and £115,000,000 in 1856; and augmented our imports from £157,000,000 in the former to £172,000,000 in the latter year."

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PROSPERITY OF THE UNITED STATES.

Thus, the influence of the increased metallic currency saved Great Britain from bankruptcy; and while its mysterious agency was working these wonders in Europe, it exercised a similar bearing in this country. Some years before the rebellion, this country had commenced to prosper; and when that deplorable event began, our resources were just beginning to expand under the beneficial influence of the increased metallic wealth. Had it not been for the constant and continuous flow from California, which increased the resources many fold, when they were most needed, the difficulties of providing the requisite means to carry on the war would have been so great that the disruption of the Union might have been the result. It has been the wonder and marvel of all Europe how the United States carried on that gigantic war for four years, kept one million of men in the field, contracted during that brief space of time a national debt of nearly $3,000,000,000, and came out in a more flourishing and prosperous condition than when they engaged in it. The explanation of this wonderful phenomenon is simple—*the magic agency of gold wrought it.*

FINANCIAL CRISIS.

Since the war is ended, the immense increase in prices, which is particularly noticeable in the large cities of the East, where real estate, rents, wages, and everything else have assumed an apparently exorbitant value, has been mainly ascribed to an inflated paper currency; and an extensive financial crisis has been predicted as a necessary consequence. We have been expecting it for three years past, and it has not taken place yet; nor do we consider it probable that it will at all occur, so long as the increase of metallic wealth keeps pace with the expansion of trade. The credit system of the United States has been much curtailed since the war, and there has been no time in our history when the business community have been less in debt. How can a great financial crisis and panic occur when no overtrading on a credit basis has taken place, and not sufficient creditors exist to make their alarm the cause of such a commercial convulsion?

THE NATIONAL DEBT.

The issuance of a depreciated paper currency during the war has had the effect, as confidence became restored, and as its metallic value increased, of en-

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riching the population at large who held that currency, enabling them to pay off their private debts; while the Government, issuing at one time as much as three paper dollars, which only had the value of one metallic dollar, became proportionally more in debt. The result, therefore, has been, that the individual debts of the American people have, to a large extent, been transferred to the Government, increasing the same to an enormous extent, and amounting, to-day, to $2,500,000,000. That debt is a burden on $16,000,000,000 of taxable property: if we increase the latter, we virtually reduce the former.

INCREASE OF TAXABLE PROPERTY IN THE UNITED STATES.

The amount of the precious metals at present in circulation throughout the world, amounts to $3,600,000,000. The proposed tunnel to the Comstock Lode will, within thirty years, add $900,000,000 to the same, or twenty-five per cent. It will consequently add twenty-five per cent. to the taxable property of the United States, equal to $4,000,000,000, which, at the rate of taxation of two per cent., will give an annual increase to the resources of this Government of $40,000,000 for each of the first thirty years, and $80,000,000 for each year thereafter.

INCREASE OF REVENUE.

The proposed work adds each year $30,000,000 to the stock of the precious metals, equal to the one hundred and twentieth part of the $3,600,000,000 in existence. It therefore adds the one hundred and twentieth part to the $16,000,000,000 of taxable property in the United States, equal to an annual increase of $133,333,333. That addition made from year to year, gives the above stated result, as will be seen by the following table:

Increase of Taxable Property.			*Increase of Revenue.*
1st year.....	$ 133,333,333	at two per cent.=	$ 2,666,666
2d year.....	266,666,666	" "	5,333,333
3d year.....	400,000,000	" "	8,000,000
6th year.....	890,000,000	" "	16,000,000
12th year.....	1,600,000,000	" "	32,000,000
15th year.....	2,000,000,000	" "	40,000,000
24th year.....	3,200,000,000	" "	64,000,000
30th year.....	4,000,000,000	" "	80,000,000

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PAYMENT OF THE NATIONAL DEBT.

If this annual increase in revenue be set apart for the purpose, it will pay off the whole National debt in forty-six years.

When Francis Bowen wrote his "Principles of Political Economy," we had no National debt. In referring to that of Great Britain, he says:

"As the depreciation goes on, taxation may be extended *pari passu* without throwing any additional burden upon the community; and a sinking fund formed out of the surplus thus obtained, would pay off the National debt in less than one generation. Our National debt, it is true, is but small, and what little there is, will quickly be extinguished. But the debts of the individual States are large, amounting in the aggregate to over $200,000,000, a large portion of which is owned in Europe. It is, therefore, satisfactory to remember that as the monetary revolution will operate exclusively to the benefit of the indebted party, our own land will derive as much benefit from it, in proportion to our means, as any other country on earth."

SIR ROBERT PEEL.

The effect of the increase of bullion on taxable property and a National debt, has been long recognized by the financiers and statesmen of Great Britain, and was enunciated in the following language, held by Sir Robert Peel, in 1844:

"There is no contract, public or private, no engagement, National or individual, which is not affected by it. The enterprises of commerce, the profits of trade, the arrangements made in all domestic relations of society, the wages of labor, pecuniary transactions of the highest amount and the lowest, *the payment of the National debt*, the provision for the National expenditure, the command which the coin of the smallest denomination has over the necessities of life, are all affected by it."

M. CHEVALIER.

M. Chevalier, the well known French writer on Political Economy, in his treatise on "The probable Fall in the Value of Gold," published in 1859, says: "Owing to the discovery of the new gold mines, a time will arrive when a change will come over the British Treasury as if some genii, an enemy of its creditors, had spirited away their dividend warrants, and substituted others of only half

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their value. Not that the number of pounds sterling, due to them as principal, and of which the interest is counted to them every six months, will be diminished—not that the quantity of gold contained in the pound sterling will be lessened; but the British Treasury will henceforth draw from the tax-payers each pound sterling, with as little difficulty to them as it previously took to pay a half-sovereign."

IMPORTANCE OF THE QUESTION.

Your Committee, in presenting the above views on the importance of the proposed tunnel as the means of furnishing a large addition to the stock of the precious metals of the world, has found it necessary to enter somewhat into details as to its bearing upon the future of the United States, and the payment of the National debt. This important question is but little understood: we have tried to throw as much light upon it, by giving quotations of eminent writers, as the limited space of a report would allow, and hope the attention of our National Legislators will be drawn towards this subject.

NATIONAL AID.

The proposed tunnel to the Comstock Lode is, in our opinion, a work of such magnitude and vast national importance, that our Government, though it has always been reluctant to aid private enterprise, and was only induced to aid the Pacific Railroad as "*a war measure*," will give such substantial aid to this enterprise as will insure its being carried out, upon the ground that it is eminently a "*peace measure.*"

B. S. MASON,
THEODORE D. EDWARDS,
WM. G. MONROE,
Committee on Federal Relations.

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LEGISLATIVE PROCEEDINGS.

NEVADA LEGISLATURE—THIRD SESSION.

SENATE—SEVENTEENTH DAY.

WEDNESDAY, January 23d, 1867.

The Senate met at the usual hour; the Lieutenant Governor in the Chair. The roll was called and a quorum present. Chaplain absent on leave.

The journal of yesterday was read and approved.

REPORTS.

Mr. Mason—Mr. President and Senators: In presenting a report of the character of that which I hold in my hand, I must first bespeak for it your candid consideration. It is a report upon the subject matter of the memorial presented by the Senator from Storey (Mr. Sumner) yesterday; a report which has occupied a great deal of time in its preparation, and one which eminently deserves and calls for your most candid consideration. The facts enunciated, the principles set forth, the erudition displayed in its preparation, drawing for its details on the works of original minds from Adam Smith, Descartes and Hume, to John Stuart Mill, touching upon the subject of political economy, may secure such results from Congress as will place us, insignificant as Nevada now may be, upon a proud pinnacle of fame. And the individual who has the honor of conceiving the idea of the Sutro Tunnel—what I consider to be one of the boldest conceptions of our time—is entitled to the eternal gratitude of the people of Nevada, even if it never be completed. The Committee on Federal Relations, to whom was referred a memorial entitled "Joint Memorial and Resolutions, asking Government aid in the construction of the Sutro Tunnel," beg leave to report the same back, and recommend its passage.

The yeas and noes were called, and the same passed unanimously.

On motion of Mr. Grey, 2,000 copies of the Joint Memorial and Resolutions, together with the Report of the Committee on Federal Relations, were ordered printed.

SENATE—EIGHTEENTH DAY.

THURSDAY, January 24th, 1867.

By Mr. Doron—

Resolved, That 500 copies of the Memorial and Joint Resolutions in reference to the Sutro Tunnel, and of the report of the Committee on Federal Relations thereon, be delivered to A. Sutro, for distribution at the seat of Government of the United States. Adopted.

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ASSEMBLY—EIGHTEENTH DAY.

THURSDAY, January 24th.

AFTERNOON SESSION.

At 1 o'clock, P. M., after a call of the House, speaker *pro tem.* Julien in the chair, the general file was taken up.

FROM THE SENATE.

Transmitting Senate Joint Memorial and Resolutions, asking Government aid in the construction of the Sutro Tunnel to the Comstock Ledge.

On motion of Mr. Mayhugh, the rules were suspended, and the resolutions were read a third time.

Mr. Munckton said he hoped that there would not be a dissenting voice on the final passage of these resolutions. The project was one of the greatest of the age, and most important to the State, and involved the prosperity and future success of our mining interests. Money, all knew, was one of the great moving powers of all nations. The work, when completed, would be the means of putting in circulation untold millions of mineral wealth.

Mr. Jones regarded the project as of vast importance, not simply as a beneficial result, financially, to the United States, but as an index work. He wanted this one demonstration or test of the continuation of the Comstock Lode, in the way that it would be by the Sutro Tunnel. This aid was asked of the Government for experimental purposes; and if it proved satisfactorily the existence of deep metal-bearing lodes, then from the Missouri to the Pacific millions of dollars would flow into the national treasury. Then would the permanency of our mines be established, and capital for their development flow in upon us, seeking investment in projects similar to that for which aid is asked, and no aid need afterwards be asked of Government. He concurred with Mr. Munckton in the hope that there would be no dissenting voice on the final passage of the resolutions.

The resolutions passed by a unanimous vote.

SENATE—NINETEENTH DAY.

FRIDAY, January 25th, 1867,

Senate met at the usual hour; the Lieutenant Governor in the chair. The roll was called, and a quorum present. Prayer by the Chaplain.

The journal of yesterday was read and approved.

RESOLUTIONS—SUTRO TUNNEL.

By Mr. Sumner—

Resolved. By the Senate, the Assembly concurring, that the Legislature of Nevada recognize, as already due, and cordially extend the thanks of the people of this State to Adolph

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Sutro, for his great service in originating the Sutro Tunnel, and urging aid and organization for undertaking work upon the same; and be it further concurrently

Resolved, That we have entire confidence in the ability of Mr. Sutro to present to Congressmen and capitalists, the claims of the enterprise referred to, knowing that he will prepare, with skill, and clearly exhibit the whole statistical and politico-economical arguments bearing in its favor, without overlooking or exaggerating any of its merits.

Mr. Sumner—I have no apology to offer for introducing these resolutions; although they may seem superfluous, inasmuch as we have passed a resolution, under a memorial, touching the subject matter here referred to. We have already formerly commended the project, which is all the originator himself asks. But, sir, I desire that the author of this great enterprise, in which the citizens of Storey county feel a profound interest, should, when he goes from among us to the bankers of the East and of Europe, at least experience for himself that he has the sympathies of the people of this State. And it seemed to me that such a special resolution was called for, in some measure, inasmuch as merchants in San Francisco, that, by accident, have fallen into seats in the director's rooms of mining companies whose works are located in this State, and upon the Comstock Ledge, have undertaken to disparage Mr. Sutro's earnest, intelligent and self-sacrificing efforts, and to belittle the plan which he originated. I say, fortunate is that commonwealth which has men of such public spirit as Mr. Adolph Sutro has evinced in connection with the proposed tunnel which is to be called by his name; such indefatigable zeal; such a temper to face the discouragements and endure, with complacency and unabated determination, the scoffs of the incredulous, and still push forward toward a successful commencement and consummation. I know, sir, that this proposition for a personal indorsement is unusual. But the project named is itself unusual in its need and necessities. If carried out, it is to revolutionize, in a great degree, the present system of mining in the principal mining districts of this State; and will, so far as it proves a successful experiment, indicate what may be done for convenient and exhaustive mining in other and newly developed portions of Nevada. It is to be reasonably expected that the next journey East, of the gentleman referred to, somewhat encouraged and aided by the resolutions we adopt, will result in a positive success. I think that this benediction—if I may be permitted to so entitle it—from the Legislature of Nevada, upon Mr. Sutro, may be of benefit—beneficial to him—that he may be successful; and if he succeed, returning benefits incalculable to my constituency, and to the people of this State, and of this nation.

The ayes and noes were demanded, and the resolution unanimously passed, as follows:

Ayes—Doron, Eastman, Edwards, Geller, Grey, Hastings, Hutchins, Linn, Mason, Meder, Monroe, Proctor, Sumner, Terry, Welty—15.

ASSEMBLY—NINETEENTH DAY.

FRIDAY, January 25th, 1867.

Resolutions complimentary to Adolph Sutro—passed unanimously.

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SENATE—TWENTY-FOURTH DAY.

WEDNESDAY, January 30th, 1867.

Senate met persuant to adjournment, the President in the Chair. The roll was called, and a quorum present. Chaplain absent.

MOTIONS AND RESOLUTIONS.

By Mr. Grey:

Resolved. That the Secretary of the Senate be authorized and required to prepare a handsomely engrossed copy of the Senate concurrent resolutions relating to Adolph Sutro, signed by the officers of the two Houses, and forward the same to the person therein named. Adopted.

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The Comstock Lode:

ITS CHARACTER, AND THE PROBABLE MODE OF ITS CONTINUANCE IN DEPTH.

By Ferdinand Baron Richthofen, Dr. Phil.

NOVEMBER 22d, 1865.

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TO THE

BOARD OF TRUSTEES OF THE SUTRO TUNNEL COMPANY.

VIRGINIA, NEV., November 22d, 1865.

GENTLEMEN:

In compliance with your request, I beg to submit the subjoined statement of my views in regard to the character of the Comstock vein and the probable mode of its continuance in depth, as well as the necessity of constructing a deep adit-level for the purpose of draining and ventilation.

I have had, during my sojourn in the Pacific States, repeated opportunities of visiting the Washoe region, and have made its geology and the structure of the Comstock vein, the object of my careful investigation. In the course of my explorations, I have become more and more impressed with the necessity of securing the future profitable productiveness of the Comstock vein and the prosperity of a numerous population by the great work which you propose to execute, and for which few silver mines throughout the world offer greater inducements, while none can boast of equal facilities. I, therefore, cheerfully embrace the opportunity which you offer me, to aid in promoting an enterprise of lasting value, upon the execution of which depends the future of the mines on the Comstock vein.

Hoping sincerely that you may meet with success,

I remain, gentlemen,

Yours, very respectfully,

F. B. RICHTHOFEN.

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CHARACTER OF THE COMSTOCK VEIN.

The Comstock Lode, in the State of Nevada, may be ranked among the richest and most productive metalliferous deposits which in historical time are on record in any part of the world: and, although but a short time has elapsed since its discovery, it adds considerably to the present production of silver. Its produce has been:

YEAR.	TOTAL.	SILVER	GOLD.
1862.....	about $ 4,000,000	about $ 2,500,000	about $1,500,000
1863.....	" 12,000,000	" 8,000,000	" 4,000,000
1864.....	" 16,000,000	" 11,000,000	" 5,000,000
1865.....	" 16,000,000	" 11,250,000	" 4,750,000
Total produce 1862 to 1865.....	$48,000,000	$32,750,000	$15,250,000

If it is considered that in 1854, since which time the annual production of silver in other parts of the world has not undergone great changes, the total amount of silver produced was, according to Prof. Whitney, $47,443,200 of which sum $7,864,000 came from European, and $39,451,200 from American mines, it will be seen that the produce of silver (deducting the gold) of the Comstock vein, in the last three years, was about twenty-three per centum of the entire amount furnished by all the silver mines in the world. It exceeds the aggregate produce of all European countries, and equals that of the entire Western coast of South America, which in 1854 was $11,099,200. The only country to which it is inferior, is Mexico. But it would, of course, be unfair to compare the produce of one single vein with that of the country which exceeds all others in the abundance of silver-bearing veins.

The extraordinary productiveness has made the Washoe-region more famous for its mineral wealth than many places where silver ores have been mined and extracted for centuries. It has attracted a numerous civilized population to a country, which before was sparsely inhabited by wandering Indian tribes, and which, by its desert character, seemed to debar forever human industry and arts;

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it has built cities in this desert, and roads across high mountain ranges, and at the present time accelerates the connection by steam of the Atlantic and Pacific coasts of America; it has created a new branch of mining in the Pacific States, which, through the discovery of the Comstock vein, has assumed gigantic proportions all over the Great Basin; it has given successful employment to large amounts of capital, and rescued the trade of California from imminent decline at a time when the placer mines were rapidly decreasing in importance.

Yet, notwithstanding the achievement of such remarkable results in the space of a few years, the question arises, whether the mining interest of Washoe, the only source of wealth indeed which this country possesses, is going to decline and attain the end of a few years history, or whether it is going to last for a long time to come, and if so, by what means its future existence and greatness may be promoted? There are not a few, and among them men of prominent intellect and experience, who are of the opinion that the era of the productiveness of Washoe is fast approaching its end, the Comstock vein being a gash-vein terminating in depth in the shape of a wedge, and who, on the strength of this preconceived idea, would reject any means proposed for securing lasting profits. It is, therefore, a matter of no small importance to investigate the nature of the Comstock vein, for the purpose of arriving at definite conclusions as to its true nature and the prospects of its further successful exploration.

It may be objected, that after only a few years of mining the true nature of a mineral deposit can hardly be understood. But it must be borne in mind that probably no mine ever fell, from the day of its discovery, into the hands of so enterprising and energetic a population as that engaged on the Comstock vein, and no metalliferous deposit ever was developed so fast, not even excepting the great Potosi mine in Bolivia. The amount of work done in Washoe would, under ordinary circumstances, at the slow rate at which mining is conducted in other countries, have required five or six times as many years for its execution.

Numerous facts of importance have been brought to light by these explorations, and these have to be collected and compared, in order to arrive at definite conclusions as to the character of the Comstock vein so frequently and bitterly discussed in the courts of Virginia City, and to solve satisfactorily many important problems, such as the following questions: Will the vein extend downwards to an indefinite depth? Will its metallic yield increase or decrease

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in depth, or will it remain stationary? What means have to be applied to make deep working profitable? Will the vein retain its dip in depth? etc. There is also considerable general interest connected with these researches, inasmuch as scarcely ever, since geology has taken its place among the inductive sciences, has opportunity been given for studying the character near the surface, of a metalliferous vein of equal magnitude, since almost every one had been worked to great depth before the practical use of such investigations began to be appreciated.

OUTLINES OF THE GEOLOGY OF WASHOE.

The range of the Washoe mountains, on which the Comstock vein is situated, is separated from the steep eastern slope of the Sierra Nevada by a continuous meridional depression marked by the deep basins of Truckee valley, Washoe valley, and Carson valley. Its shape is irregular, though in general a direction from south to north may be traced in the summit range. South, it slopes gradually down to a smooth table-land, traversed from west to east by the Carson river flowing in a narrow crevice, beyond which the Washoe range continues in the more elevated Pine-Nut Mountains. Some peaks in the latter have an altitude of probably more than nine thousand feet. To the west the Washoe mountains descend rapidly and sink beneath the detrital beds of Washoe valley and Truckee valley, but are connected with the Sierra Nevada by two low granite ridges stretching, at right angles with its general course, across the northern and southern ends of Washoe valley, and thus isolating its basin. To the north and east, the Washoe range passes into a very extensive mountainous region which is but little explored; while to the south-east it disappears abruptly below one of the middle basins of Carson river. The width of the entire range is not more than fourteen miles, while its length from north to south is not yet determinable, on account of the scanty knowledge we possess about the northern parts of the country. The culminating point of the range is Mount Davidson, the elevation of which was determined by Professor J. D. Whitney as 7,827 feet. The altitudes of other places are: Virginia City, (B Street) 6,205 feet; Devil's Gate, 5,105 feet; while the basins to the west and south, have the following elevations: Washoe Lake, 5,006 feet; Carson City, 4,615 feet; Dayton, 4,490 feet; all according to barometrical measurement by Professor Whitney.

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The summit range, which extends northerly and southerly from Mount Davidson, forms the water-shed; deep gulches, marking the intense eroding action of currents in former times, though now almost entirely dry, descend from it down to the basins.

The aspect of the Washoe mountains is exceedingly barren; so is the view from Virginia over the hilly country to the east. Yet, there is a remarkable grandeur and sublimity in it. The air is extraordinarily pure and transparent, so as to allow every gulch and declivity in the slope of mountains a hundred miles off to be distinguished. The eye wanders over an unbroken desert, where barren hills alternate with wide and sandy basins. There is no beauty in this scenery, but it has a strange charm; the constant enjoyment of the distant view is a redeeming feature of life in Virginia.

At the time of the discovery of the Comstock vein, the Washoe mountains are said to have been covered with scattered trees of the nut-pine and cedar. But since then, they have been extirpated, and Virginia depends for its supply of wood and timber chiefly on the slope of the Sierra Nevada, which, down to the beforementioned depression, is covered with a continuous forest. The enormous consumption of hewn timber in the mines is, however, rapidly bringing about the destruction of the better part of those forests, and the supply will soon have to be obtained from a greater and greater distance. It is almost unlimited on Truckee river, at thirty miles distance from Virginia, but this will only be made available by the construction of a railroad from that place to the mines.

The situation of Washoe in the westernmost part of the great basin, and immediately east of the steep eastern slope of the Sierra Nevada, causes it, in its geological features, to form an intermediate link between the structure of both of them, though it partakes far more of the diversified composition peculiar to the mountain ranges of the Great Basin. To the Sierra Nevada it is related by the metamorphism of its sedimentary formations, which farther east appear more regularly stratified and less altered. With both it has in common the considerable part which tertiary and post-tertiary eruptive rocks, partly of pure volcanic origin, play in its architecture. We mention in the following only the more important rocks:

Mount Davidson, the prominent central point, consists of *Syenite*, a granatic rock, which here is composed of two kinds of feldspar, (orthoclase and oligoclase,) hornblende in laminated prisms of greenish black color, some mica, and occa-

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sionally epidote, but no quartz. It is probably a continuation of the granitic axis of the Pine-Nut mountains, and forms with the *Metamorphic rocks*, which accompany it, the backbone of the Washoe mountains. The latter rocks join the syenite to the north and south, and are intersected by dykes of that rock, thereby proving its later origin. Lithologically, they exhibit a great variety; but they may be subdivided in three distinct groups, one of which is *of Triassic age*, and was first discovered by Prof. J. D. Whitney in Eldorado Cañon near Dayton; this is the most recent group, and its rocks are ordinarily but little metamorphosed. They are immediately preceded in age by a series of *micaceous and quartzose slates*, which usually contain some beds of limestone. Both these groups occur only at some distance from the Comstock vein. Of more importance for the latter is a third series, of *hornblendic* (uralitic) *rocks*, with interstratified layers of quartzite, gray slate, and crystalline limestone, which is often accompanied by extensive deposits of very pure specular iron. These rocks form the hills which flank American Flat to the west, as well as those between Silver City and Carson. They are capped by an overflow of *Quartzose porphyry*, an eruptive rock, which, however, is of no importance, except as forming the footwall of the Justis vein.

These rocks form the *ancient series*. They partly preceded, and partly were contemporaneous with the gradual emergence of the Sierra Nevada and the Great Basin, and the entire chain of the Cordilleras, from the ancient sea, whose traces are left in saline incrustations and salt pools at the bottom of the numerous basins between the Sierra Nevada and the Rocky Mountains, which had formerly remained filled with the water of the retiring sea. The Washoe mountains formed undoubtedly an elevated range during the long period which elapsed till the commencement of the formation of the *recent series* of rocks, which bear still closer relation to the Comstock vein than the former. These rocks are eruptive and volcanic, and belong to the latter part of the tertiary and to the post-tertiary periods.

To the first of them in age we apply the recently introduced term: *Propylite*. In Washoe the names "feldspathic porphyry" and "hornblendic porphyry" are commonly used to designate two prominent varieties of it. They are very appropriate miners' terms; but scientifically applied, would be capable of very differing interpretation. In other countries the terms "Diorite," "Dioritic por-

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phyry," "greenstone," "porphyritic greenstone," and "trachytic greenstone," have been applied, which confusion of names shows best the indistinctness of the external characters of the rock. Propylite has this remarkable peculiarity, namely: that it resembles many ancient rocks exactly in appearance, and yet is among the most recent in origin. It is prominent among the enclosing rocks of the Comstock vein, and, besides, *encloses several, perhaps most, of the largest and most productive silver veins in the world*, as those in the Karpathian mountains, of Zacatecas and other places in Mexico, and probably several veins in Bolivia. Mineralogically, it consists of a fine-grained paste of ordinarily greenish, but sometimes gray, red, and brown color, with imbedded crystals of feldspar (oligoclase) and columns of dark-green and fibrous, seldom of black, hornblende, which is also the coloring matter of the base. A peculiarity of the rock is its ferruginous character when decomposed. Probably it contains other metals besides iron. Geologically, it is an eruptive rock; but it is accompanied by vast accumulations of breccia, which is sometimes regularly stratified. The flats of Virginia City, Gold Hill, American City, and Silver City, consist of propylite; it lies, in general, east of the mountains consisting of the ancient formations, and contains several mineral veins besides the Comstock Lode. Its distribution in other countries of the world is not very general.

Several different kinds of eruptive and volcanic rocks followed the outbreaks of propylite; but only to one of them have we to direct attention in reference to the Comstock vein, as it probably caused its formation, besides taking a prominent part in the structure of the country. It is known in Petrology by the name of Sanidin-trachyte; for convenience sake we simply use the name *Trachyte.* Its essential character is the predominance of a species of feldspar, called glassy feldspar or sanidin, which, along with hornblende and mica, is imbedded in a base or paste of a peculiarly rough texture, caused by microscopical vesicules which fill the rock. It has a beautiful appearance and presents very different colors. Several superior qualities render it of great use in Washoe as building material; all the masonry of the Gould and Curry Mill is constructed of trachyte; some laminated varieties break easily into regular blocks, used for stairs and pillars. Also ordinary varieties yield easily to the blow of the hammer, and break into conchoidal fragments; it forms, therefore, an easy blasting rock—a quality which will come considerably into account for the construction of a deep adit level.

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There is no doubt about the eruptive origin of trachyte. It even presents the aspect of volcanic lava, and this term has been applied to it in Washoe. The mode of occurrence shows that it has been ejected through long fissures, in a viscous or liquid state and at a high temperature. In some places the eruptions were subaqueous, as in the vicinity of Dayton. The entire table-land around that place is built up of stratified trachytic tufa. The solid trachyte rises from it in rugged mountains, which form an elevated and very conspicuous range, passing east of the Gould and Curry Mill, across Seven-Mile Cañon, (where, for instance, the Sugar-Loaf Peak consists of it) and bending in a semi-circle round to Washoe Lake. Pleasant Valley is entirely surrounded by trachytic hills; and farther north, this rock covers the country to great extent.

Sanidin-trachyte has never been found to contain silver-bearing veins; and in Washoe none occur in it, and yet it has evidently been mainly instrumental in the formation of the Comstock Lode and other veins in that region.

No geological events after that epoch are worth noticing, for our present object. Eruptions of basaltic rocks were considerable in adjoining parts of the Great Basin, but have been of little consequence in Washoe. Volcanic and eruptive activity gradually died away, and we behold now their last stages in the action of thermal springs, such as Steamboat Springs. The surface underwent but slow and gradual denudation, and the events of the volcanic period are recorded so perfectly and distinctly in the nature and association of the rocks, as to aid us greatly in explaining the mode of formation of the Comstock vein.

GENERAL STRUCTURE OF COMSTOCK VEIN.

The Comstock vein runs, nearly in the direction of the magnetic meridian (the variation being fifteen degrees east) along the eastern slope of the Mount Davidson range, which descends at a steep grade until it abuts against the gentle slope of three "Flats," on which, at an altitude of from five thousand eight hundred to six thousand two hundred feet, are situated the towns of Virginia, Gold Hill, and American City. The outcroppings of the vein extend in a broad belt along the foot of the steep grade and immediately above the three towns. The course of the vein, as far as yet explored, is somewhat dependent on the shape of the slope, as it partakes of all its irregularities, passing the ravines in concave bends, and inclosing the foot of the different ridges in convex

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curves; the greatest convexity is around the broad, uninterrupted foot of Mount Davidson itself. These irregularities are of importance, as they influence the ore-bearing character of the vein.

The length to which the Comstock vein has been traced with certainty, is about nineteen thousand feet, (from Utah Mine to Caledonia Tunnel, south of Overman Mine,) while its total extent is, probably, at least twenty-four thousand feet. The most extensive explorations are between the Ophir North Mine and the Overman, a distance of about eleven thousand feet; at other parts but little or only superficial work has been done. This applies particularly to the northern and southern ends, as well as to some short portions of the central part. Several mines are being worked to more than five hundred feet in depth, while some of the shafts, as those of the Mexican, Hale and Norcross, Gould and Curry, and other mines, descend to more than seven hundred feet below the outcrops. Altogether, the amount of work done up to this time is sufficient to show clearly the structure of the vein in its upper portion, and to allow well-founded conclusions to be drawn in regard to those which are below the present works.

Without entering here on the question of the "plurality of veins," or the correctness of the so-called "one ledge theory,"—the discussion of both of which has caused expensive and bitter litigation and retarded the development of Washoe, but at present is decided in the minds of probably everybody—we simply state in the following those facts which may be considered as proved by evidence.

The Comstock vein, at a depth of from four hundred to six hundred feet beneath its lowest outcrops, fills a fissure of from one hundred to one hundred and thirty and even two hundred feet in width, but contracting at places so as to allow both walls to come in close contact. Both of the latter, at that depth, descend easterly at an angle varying from forty-two to sixty degrees. Upwards, from the average depth of five hundred feet, the western wall rises to the surface with the same inclination, which, however, occasionally diminishes at upper levels, to forty and thirty-eight degrees, while the eastern wall soon bends to the vertical and gradually turns to a western dip, which at places is forty-five degrees. Its general position to the depth mentioned, is, therefore, about vertical, with an inflation to the west. The vein, consequently, expands towards the surface, in the shape of a funnel. The increase in volume is especially pro-

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duced by the intervention, between the vein-matter, of large fragments of country-rock, broken from the walls, but usually moved only a little way downward, by sliding, from their original place. The bulk and number of these fragments, or "horses," increases towards the surface, where some of them have a length of almost one thousand feet, and a width of fifty to upwards of one hundred feet. Vein-matter, branching off from below, fills the spaces between the fragments, but is generally near the surface far inferior in bulk as compared with the country-rock. The width of the belt in which these branches come to the surface, and there form scattered outcroppings, is generally more than five hundred feet.

On the western side, (west of the Virginia and El Dorado croppings,) the Comstock vein is accompanied by a number of smaller veins, the outcroppings of which are visible on Cedar Hill, Central Hill, Ophir Hill, and Mount Davidson, and are with some of them of considerable size. They are nearly parallel to the main vein, and dip to the east. Probably they will unite in depth with the Comstock vein, which, by its relation to them, may be considered as the main vein of what German miners call a "Gangzug." The western boundary of this main vein is exceedingly well defined, by a continuous clay selvage lying on the smooth foot-wall, and separating the vein-matter very distinctly from the country; but it is different on the eastern side, where the adjoining country-rock, as is often the case with true fissure-veins, is impregnated with matter similar to that which fills the fissure. It is frequently concentrated in channels running parallel to, or ascending from, the vein, but in fact forming parts of it. The well-defined east wall of its main body, has, therefore, often not the same position relatively to the entire vein, and with the growing depth gained by successive explorations, the development of vein-matter east of what was formerly considered the east wall, increases.

Enclosing Rock.—The rocks which accompany the Comstock vein, change in its course. They are different varieties of propylite on the eastern side, throughout its whole extent. In some places the frequent and large crystals of feldspar give it a porphyritic character, which in certain varieties, is rendered more striking by green columns of hornblende; at others, the rock has a very fine grain, and the enclosed crystals are of minute size; again, the rock is either compact and homogeneous, or it has a brecciated appearance from the inclosure of numerous angular fragments. Also the color changes, though it is predomi-

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nantly green, and the different degrees of decomposition create, finally, an endless variety. We will presently have occasion to consider the causes to which it is due.

The western country offers more differences. Along the slope of Mount Davidson and Mount Butler, from the Best and Belcher mine to Gold Hill, it is formed by syenite which, at some places, is separated from the vein by a fine-grained and crystalline rock of black color, having the nature of aphanite, but altogether obscure as to the mode of its occurrence. It is from three to fifty feet thick, and the elucidation of its real nature may be expected from further developments. As syenite to the west, and propylite to the east, occur just in that portion of the Comstock vein which has been most explored, and where works, more than anywhere else, extend in both directions into the country, it has been generally assumed, in Virginia, that the lode follows the plane of contact between two different kinds of rock, and is therefore a contact deposit. But immediately north of Mount Davidson, where propylite extends high up on the western hills, this rock forms the western country as well as the eastern, as at the California and Ophir mines—though at the latter, metamorphic rocks and syenite are associated with propylite, on the western side. On Cedar Hill, syenite again predominates; but, farther north, propylite forms the country on both sides. South of Gold Hill, the syenite disappears from the western wall, and its place is taken to some extent by propylite, but in greater part, by metamorphic rocks of the third of the beforementioned classes, principally quartzite and uralitic rocks. They are best exposed in the Caledonia Tunnel. Nowhere have syenite and metamorphic rocks been found occurring on the eastern side.

Outcroppings.—The outcroppings of the Comstock vein do not form a continuous line, but consist rather of small and detached ranges of quartz, ordinarily protruding from the surrounding ground, and sometimes forming bold crests, which, in the aggregate, constitute a broad interrupted belt. The horizontal distance across the vein of the outcrops of the different branches, amounts to upwards of six hundred feet. Those of the western branches, which retain the eastern dip of the western wall of the vein, carry principally crystallized quartz of very glassy appearance, ordinarily of white or at least light color, and comparatively pure quality. Angular fragments of the country-rock are imbedded in the quartz, and form the centers of its crystallization; they usually occur in

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large pieces, and not in finely-disseminated particles. Metalliferous minerals are scarce, though nowhere entirely wanting. Nothing indicates underground wealth, nor, indeed, has such been found by subsequent mining. The only exception is Cedar Hill, where native gold was found abundantly in places; but its scarce dispersion never justified great expectations. Of this nature are the Sacramento, Virginia and El Dorado outcrops, and others on Mount Davidson and Mount Butler. They have in several places a width of one hundred and twenty feet, besides other branches which form part of them.

In the eastern outcrops, particles of the country-rock, together with others of clayey matter and metallic substances, occur, finely disseminated through the quartz, causing thereby a marked difference from the character of the western outcrops. A certain porous structure of the quartz, evidently originating from the removal of fine particles of ore, and the brown and red coloring caused by metallic oxyds, indicate the ore-bearing character of large portions in depth; and the dissemination of native gold and silver in small pores and larger cavities, gives evidence of the presence of ores of the precious metals. Also the chloride and simple sulphuret of silver occur in the eastern outcrops. These different characters of the "Pacos" and "Colorados" of the Mexican and the "Iron hat" of the German miner, continue downward to varying depths.

Vein-Matter.—The vein-matter of the Comstock lode is of a highly varied character, if we consider every substance which enters into the composition of the body of the vein, between its two walls, as belonging to it. Its chief component parts are: fragments of country-rock, clay and clayey matter, quartz and ores.

Fragments of Country-rock.—Near the surface, about five-sixths of the mass of the Comstock vein consists of fragments of country-rock, "horses," as the Cornish miner calls them; they are often of larger size and then terminate below in a sharp edge. Their shape and size varies somewhat with the different nature of the rock of which they consist. Those of propylite, which along the whole range occur on the eastern side, and only occasionally extend throughout the whole vein where the country is of the same character on both sides, are ordinarily very much elongated in the direction of the vein, frequently to one thousand feet or more, while their breadth is far inferior and their height is intermediate between both. At their ends they thin out gradually. Those of syenite terminate more abruptly and their dimensions are more equal, though they

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are always largest in the direction of the strike of the vein. From the large "horses" every variety of size occurs down to the smallest fragments. The quartz is often so thickly filled with angular pieces as to have a brecciated appearance. Propylite is more common among them than syenite, and brecciated vein-matter is therefore prevalent in those parts of the lode where propylite encloses the same on both sides, or where, at least, it furnished the larger part of the material for the "horses." It is for this reason abundant in the California, Central and Ophir mines, and in the southern part of the Gold Hill mines.

Clay and Clayey Matter.—Few large veins are so abundant in these substances as the Comstock vein. Clay forms the western and eastern selvages from north to south in continuous sheets, sometimes of from ten to twenty feet in thickness. Other sheets of clay divide "horses" from quartz or different bodies of the latter; and where the two walls come in close contact, they have at places a united width of from fifty to sixty feet. This clay is ordinarily tough and putty-like, and contains rounded pebbles of the adjoining rock; only where quartz is on both sides, it partakes of its nature and is more earthy and dry. But, besides, clayey matter occurs in the body of the vein to great extent, and at places takes a prominent part in the filling of the fissure. Most "horses" terminate at their lower end in a clayey substance, and continue downwards, as well as in the direction of the vein, as sheets of clay. Outside of the vein the same matter occurs to great extent in the eastern country, but scarcely, if ever, in the western, thereby giving another evidence of the indistinctness of the eastern boundary of the vein.

Quartz.—The differences mentioned before as prevailing in the quartz of the outcrops continue downward; but are not so conspicuous in depth, on account of the general white color of the quartz. But even there the finely-disseminated particles of the wall-rock are more peculiar to the eastern than to the western portions, and are always abundant where the quartz contains ore. At upper levels, some bodies of quartz are of a reddish color; this is where the "colorados" continue downwards. Frequently, however, this color is only due to the red clay filling the fissures of the fractured quartz. In this case it is probably produced by the percolation of the vein-matter, by water, while in the former it is likely that it is connected with the original formation of the vein, as all the phenomena presented by the "iron hat." The quartz in the Comstock vein is rarely solid, and blasting is applied for its removal in but few

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instances. Generally, it is fractured, and, at numerous places the effects of dynamical action on it are such as to give it the appearance of crushed sugar. It occurs in this condition almost always when enclosed in clayey matter, and then frequently reminds one of the waving lines of damask. But then, also, large and continuous bodies, consisting entirely of "crushed quartz," as we may call it, are occasionally met with. Such was the case throughout the larger part of the great "bonanza" of the Ophir mine.

Ores.—The principal silver ores of the Comstock Lode are: stephanite, vitreous silver ore, native silver, and very rich galena; in small quantities occur: pyrargyrite or ruby silver, hornsilver and polybasite. Besides these are found: native gold, iron pyrites, copper pyrites, zincblende, carbonate of lead, pyromorphite (both the two last named very scarce.)

Other Minerals.—The Comstock vein is remarkably poor in a mineralogical point of view. The ores are seldom crystallized, and specimens, which at other mines would be considered very common, are admired in Virginia as rarities. In regard to the accidental minerals the same might be said, as they do not occur in either rare or beautiful forms. Quartz is the only gangue. Carbonate of lime very seldom accompanies it, while other carbonates, as those of lead and copper, have only in a few instances been observed. Sulphates are abundant in the waters which issue from the mine, and cover the walls of the old drifts. But the only one forming an essential part of the vein, is gypsum, which occurs in a number of places; it abounds in the lowest works of the Gould and Curry mine, and was formerly found in large crystals in the Fairview. Sulphate of baryta has not yet been observed. Zeolites are limited to the northern portion of the vein, where chabasite and stilbite fill small fissures and cavities in propylitic breccia within the body of the vein.

Distribution of Ores in the Vein—(a) *North of Gold Hill.*—The ore is distributed in a different way in the northern and in the southern part of the Comstock vein. The passage between the two modes of occurrence is gradual. In the northern part the ore is concentrated in elongated lenticular masses, of which the greatest axis is not far from the vertical, but dips to the south and sometimes also to the east. Their width across the vein varies from fifteen to fifty feet. Sometimes several of them adjoin each other laterally in such way, that the westernmost one extends farther north than the one adjoining to the east, and this again, farther than its next eastern neighbor. This is most con-

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spicuous in the Gould and Curry and Savage mines, where, at the same time, the western bodies extend, in general, higher up towards the surface. Three or four bodies of ore, arranged in the way described, and either separated by country-rock or adjoining each other closely, may be distinguished in these mines. Their total length from the north-western to the south-eastern and lower end, is about six hundred and fifty feet: their aggregate width about one hundred to one hundred and twenty feet; while their extent downwards is not yet known. They belong to the middle and eastern portion of the vein. The ore has been exceedingly rich in the center of the different bodies, where, at the same time, it was soft and could easily be removed, while the outer parts are hard, and consist of second-class and low-grade ores. Upwards of twenty millions of dollars have been extracted from this immense bonanza. In the Ophir and Mexican mines only one body of similar shape was found. It commenced on the surface, where it was only two feet wide, and descended to the depth of three hundred and thirty feet. It first gradually increased in width, until it reached forty-five to fifty feet, which was the maximum: then, it thinned out again in its downward course, and terminated as narrow as it commenced. As it was next to the east wall, it dipped with that towards the west, near the surface; then, in its widest portion, straightened out and gradually turned to an eastern dip, with which it terminated. The length of this body was two hundred feet; it appears that about seven millions of dollars have been extracted from it, with the imperfect processes used during the first years of mining at Washoe. This deposit was accompanied to the west, at about forty feet distance, by another body of ore, which, however, had the shape of a narrow sheet, its total width being six to fifteen feet, and its length about three hundred and eighty feet. It was parallel to the western boundary plane of the former body, but extended north and south beyond its limits, though, generally, it did not reach to equal depth; in the Mexican, however, it continued downward about three hundred and fifty feet. The amount extracted was about three and a half millions of dollars. Compared with the first body, it contained a large proportion of lead and copper.

The space between the Ophir and Gould and Curry mines has yielded but very little ore. The Central mine extracted some from the continuation of the deposits worked in the Ophir, and the California found a large body of quartz extending to its lowest level, but the ore was scattered and rarely of rich quality.

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The next four mines south of it, and the northern half of the Gould and Curry mine, have been unproductive. But the explorations were not extended more than a few hundred feet beneath the surface.

The southern part of the Savage mine, and the Hale and Norcross, have been almost entirely unproductive, though both of them offer good prospects for finding ore in depth. But with the Chollar-Potosi commences another rich part of the Comstock vein. On the northern line are the so-called Bajazet chimneys, two bodies of ore, separated by about eighteen feet of barren rock, each from twelve to twenty feet wide and about eighty feet long. They have been worked several hundred feet down, and their end seems not yet to have been reached. Their greater axis dips about sixty degrees to the south. With the next deposit to the south, a different shape makes its appearance, which is more perfectly developed in Gold Hill, that of very long and narrow sheets of ore intercalated in the quartz and parallel to the eastern wall, or at least to a distinct clay seam which bounds the main body of quartz to the east. The Potosi deposit is about two hundred feet long, and contained rich ore to the width of from six to twenty-three feet. It commenced near the surface and has been mined without interruption to the depth of four hundred and ninety feet. Its northern and southern boundary lines dip south. A considerable body of poor ore lies adjacent to and parallel with it, and is at present being extracted. Some narrow "chimneys" have been found in lower levels west of this body. After some interruption the latter continues along the so-called eastern clay for a long way, and has been explored by the Chollar company. It first made its appearance at the depth of about three hundred and eighty feet, and had at one place a width of fifty-five feet; but it soon terminated in depth. The entire length of the eastern body of ore of the Chollar-Potosi mine, excluding the Bajazet chimneys but including some short interruptions, is about seven hundred and fifty feet; and even farther south ore occurs along the eastern clay, but scattered and not worth extracting at the present time. Quartz fills here the entire width of the vein from the western to the eastern wall, and in no part can its unity be more clearly recognized. It continues with a similar character in the Bullion mine, the northern part of which consists entirely of ore-bearing quartz of about one hundred and twenty feet in width. But at the levels worked up to this time it is too poor for extraction, as the ore is not concentrated in distinct bodies.

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(b) *At Gold Hill and South of it.*—The occurrence of ore in "chimneys," and of barren portions between them, ceases entirely at the divide between Virginia and Gold Hill. The great wealth of the mines south of it consists in the continuous ore-bearing character of the lode for a length of fifteen hundred and forty feet, from the Alpha mine to the middle part of the Yellow Jacket, and of other extensive portions farther south. The vein is by no means ore-bearing in its entire width; but the ore is concentrated in continuons sheets, the principal one of which is very near and parallel to the eastern wall, and but little interrupted in its entire length. Its widest places, which are from forty to fifty-five feet, are in the Imperial, Bacon, and Empire mines, and again in the Yellow Jacket. In most places it commenced at from one hundred and fifty to two hundred and fifty feet below the surface; and in many mines it is still worked at their lowest levels. It is wider in the three first-mentioned mines because there united into one mass. South of the Empire it forks into three branches, the two western ones continuing in an irregular way. Besides this very extensive eastern body, there is another one in the Gold Hill mines farther to the west, which extends from the outcroppings down to from one hundred to two hundred and fifty feet in depth, and dips at an angle of fifty to sixty degrees to the west. It was worked out in the early and most flourishing time of Gold Hill, and considerable amounts were extracted, as its width was from twelve to twenty-two feet, and the ore very rich, particularly in gold. It continued in length, without interruption, for about five hundred feet. A similar body was worked out in the Yellow Jacket, the Crown Point, and the Belcher. It was not quite continuous, but at each of the three places was several hundred feet in length. Everywhere it dips to the west at about sixty degrees, and at some depth, which, as we recede from the northern Gold Hill mines, slightly but constantly increases, flattens out to the west, the bottom being nothing but clay in horizontal layers. Also its southern portion was remarkable for its high yield in gold, and for its rich ores in general, but its width was here only from six to twelve feet. The southernmost continuation of this body was found in the Overman mine, where it is likewise rich in gold, but is limited in extent.

The upper portions of the Gold Hill mines are but little explored, and even at lower levels the works were never extended to the western branches of the vein. When the bottom of the first deposit was reached and its wealth found to terminate in clay, the owners of the mines became discouraged; but explora-

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tions from that clayey bottom towards the east, brought them to the place where the real wealth of their mines is accumulated, and will probably last for a long time to come. The eastern bodies were first found in Gold Hill proper, then in the Yellow Jacket, the Kentucky, and Crown Point, while the Belcher and Overman mines have not yet succeeded in finding them.

Another subject which we have to consider, in connection with the mode of distribution of the ore, is the change in its yield. It is a matter known to every Washoe miner that, in general, it has decreased. The deposits of the Ophir, and Mexican, and of the Gould and Curry, were the richest. The former yielded, at an average, one hundred and seven dollars per ton; the latter, seventy to eighty dollars, notwithstanding the imperfect processes of extraction which were formerly applied. Ores of six hundred dollars to the ton were then no rarity, and considerable shipments could be made of such as yielded from two thousand to three thousand dollars to the ton. It would now scarcely be possible to collect one ton of such ore, excepting when old works, in the highest levels, are being overhauled. Ores of three hundred to four hundred dollars are now of as rare occurrence as formerly those of fifteen hundred to two thousand dollars. The yield of the middle and low-grade ores has also considerably diminished; and, by far, the majority of the ore, which is being extracted at this day, contains at an average not more than thirty to thirty-two dollars, while the general average of all the ores will not be more than thirty-seven dollars to the ton. This decrease applies for the total amount of ore extracted; but it is equally true for every single mine. The quantity of ore extracted has remained stationary for a long time past, and is now about twelve hundred and fifty tons daily. But the methods of reduction have improved, and their expenses been diminished; therefore, ores of lower grade than formerly can now be worked profitably.

During the early period of the working on the Comstock Lode, the proportion of gold and silver changed considerably, the yield in gold decreasing constantly. But as a greater depth is being reached, the proportion of gold is again on the increase.

As some general rules, in regard to the mode of distribution of the ore, may be observed:

1st. The ore is, in the northern part of the vein, concentrated in chimneys, dipping at an angle of sixty to eighty degrees to the south; in the southern

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part, it forms continuous sheets of great length, but which are comparatively narrow.

2d. These deposits of ore are enclosed in the eastern and sometimes also in the middle portion of the vein; the western branches are barren or poor.

3d. The richest and largest deposits have been found at those places where the outcrops (including those of the western branches) were most prominent, namely: at the Ophir, the Gould and Curry, the Savage, the Chollar, the Gold Hill mines, the Yellow Jacket, the Crown Point, and Belcher.

4th. In the northern part the vein is, at the levels explored up to the present time, invariably poor where it passes a ravine, (as in Ophir, Central, Mount Davidson ravines, and the one which divides Mount Davidson from Mount Butler.) But in the southern part, the ore continues in the ravines (Kentucky mine and Segregated Belcher.)

5th. The richest portions are south of each ravine crossed by the vein.

6th. All the chimneys in the northern part are at those places where the walls from close contact rapidly diverge to the south and cause the vein to expand.

7th. All the principal accumulations of ore are at those places where most room was given in the fissure for the deposition of quartz, and are therefore generally rare where an unusual amount of "horses" obstruct the vein (except North Potosi chimney in Gould and Curry mine.)

I have dwelt on the subject of the distribution of the ore in the Comstock vein to some length, because I consider its examination as being of great importance to enable us to draw conclusions in regard to the mode of continuance of the vein in depth.

COMSTOCK VEIN A TRUE FISSURE VEIN.

A true fissure vein may be designated as *a fissure proceeding from indefinite depth and filled mainly from below, by chemical processes, with matter differing in nature from the country-rock.* Great importance appears lately to have been attached to the question whether the Comstock vein is a true fissure vein or not. Though it would be a perfect absurdity to range it among any other class of mineral veins, yet this question will be examined in the following pages, and I will try to show that the Comstock vein possesses more than almost any other

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vein, all the peculiar features of a true fissure vein. As such may be considered:

1*st. A true fissure vein extends indiscriminately through different rocks.* It was mentioned in the foregoing pages that the Comstock Lode is but in part of its course enclosed between syenite and propylite on both sides, and, again, at others has metamorphic slate, especially quartzite and hornblendic rocks, on the western, and propylite on the eastern side.

2*d. True fissure veins extend down to indefinite depth.* This fact cannot be practically proved in any other way than by following the vein in its downward course. A few veins have been worked to the depth of a little over 2,000 feet. This is very inconsiderable compared with the depth to which true fissure veins are assumed to extend. There is, in fact, in regard to this question, but little difference whether works on a mineral lode extend to the depth of 500 or to that of 3,000 feet below the surface, as it may in either case terminate at a limited depth with equal likelihood, unless strong and convincing reasons make it evident that the vein, having the character of a true fissure vein, extends downwards indefinitely. Comparison with metalliferous veins of other countries would easily show that it is highly probable that the Comstock vein, which exceeds almost all of them in the magnitude of its proportions, extends to as great a depth as has yet been reached by mining in any country. Farther on, we shall be able to adduce evidence sufficient to demonstrate not only the probability, but almost the certainty of the continuance of this vein in depth, in speaking of the mode of formation of the Comstock vein.

3*d. True fissure veins show evidences of dynamic action*, besides the mere act of the opening of the fissure. Not only has the country-rock on one side generally moved downward on the other, but also within the space formed by the opening of the fissure powerful dynamic action has taken place. Few veins present these phenomena so distinctly as the Comstock vein, the eastern side of which has apparently moved downward on the western. The "horses," besides, and the numerous fragments causing the brecciated structure of parts of the vein-matter, the clay-selvages accompanying it on both sides, the clay-seams and masses of clayey matter in the body of the vein, the waving damask lines of the crushed quartz enclosed in the clayey matter, all these phenomena furnish ample evidence of violent and extensive dynamic action having taken place within the body of the vein. The Comstock vein possesses a certain plasticity shared by

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few other veins, which allowed that action to manifest itself on a grander scale than it usually does.

4th. True fissure veins are ordinarily found to be connected with the ejection of some eruptive rock, and where this is not visible at the surface, disturbances of strata and metamorphic action make its presence underground probable. With the Comstock vein, this accompanying rock, which was instrumental in its formation, is plainly visible. It does not require great sagacity to see at once the intimate connection which exists between the formation of the fissure as well as its filling, and the outbursts of the before-mentioned trachytic rocks which form a range of hills east of the vein and almost parallel to it, at about two miles distance.

5th. True fissure veins are filled mainly from below, and essentially by chemical action. This statement, as well as the foregoing, we shall try to prove for the Comstock vein in treating of the mode of its formation.

We shall now turn to the negative proof, that the Comstock vein can only be a true fissure vein because it possesses none of the characteristics of any other class of mineral veins. We may, besides the true fissure veins, distinguish the following classes: gash-veins, segregated veins, contact veins, and intrusive veins.

Gash-veins fill crevices limited to the formation in which they occur, that is to say, not passing from one set of beds into another of a different character. The crevices have their origin in shrinkage, from loss of moisture or diminution of heat; the filling is mainly due to infiltration from above and from the sides, and to precipitation from the water of springs. The magnitude of the fissure of the Comstock vein excludes those modes of origin which created the limited crevices of gash-veins, and must have a grander and more deep-seated cause.

The fact that it passes through rocks of very different nature, also removes it far from gash-veins in character. Moreover, it would be impossible to explain, even if fissures having the nature of gash-veins could attain such magnitude, the mode of filling them with substances such as the Comstock vein contains, either as to quantity of vein-matter, or the quantitative proportion of different metals, or the mode of their combinations. It may also be noticed that gash-veins are of far rarer occurrence than is ordinarily supposed. It appears, that especially all silver lodes, that is, those which contain this metal in sufficient quantity to make it the chief object of mining, are true fissure veins. This

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character is proved beyond doubt for the veins of the Carpathian mountains, of Freiberg, the Hartz mountains, the provinces of Murcia and Granada in Spain, and it appears to be even true for those of Kongsberg in Norway, which are seldom more than one inch wide, but have been followed with great regularity downward to the depth of 1,800 feet. For the generality of the silver veins of Mexico it is likewise an established fact; and only for those of South America some doubt was entertained, and many of them were supposed to be gash-veins. But this is proved not to be the case as mining works become more extended; on the different lodes of the three greatest mining countries in South America: Pasco in Peru, Potosi in Bolivia, and Chañarcillo in Chili, the character of the silver-bearing lodes as true fissure veins is established beyond doubt. If no other proofs of the continuity of the Comstock vein in depth could be given, it would yet be preposterous to consider one of the greatest silver veins a gash-vein, since no argentiferous lode has ever yet been proved to be of this character, not even those which are smallest and least developed.

Segregated veins, according to Whitney, do not occupy a previously-existing fissure in the rock, being so enclosed and limited on all sides by it as to show that the metalliferous and mineral substances of which they are made up, could not have been introduced into their present position in any other way than by gradual elimination of their component particles from the surrounding formation. They usually occur in metamorphic rocks, and lie parallel to their cleavage planes. They have no clay-selvages, and contain no "horses," so there could be no appearance of dynamic action within the vein. It is evident that the Comstock vein does not belong to this class.

Metalliferous deposits at the contact of two different formations are ordinarily of irregular shape, but they frequently form *Contact veins* with selvages. The Comstock vein has been considered to be of that character, on account of its following the plane of contact between syenite and propylite. But the proof which we have given in the preceding pages of its passage into different kinds of rock, and its partial enclosure by propylite on both sides, is sufficient to show that the formation of the fissure was only in so far dependent on the contact between two different formations as it followed the same accidentally in part of its course, probably because the resistance along it was inferior to that offered by the solid masses of rock on either side.

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Uniformity of composition from one wall to the other, and equally through the whole extent in length, is one of the characteristic features of all *Intrusive veins*, part of which are ordinarily called *dykes;* these are homogeneous throughout, except that the texture of the crystalline matter may be coarser or finer in places. They have been formed by the forcible injection of liquid matter from below into a previously formed fissure. They never possess clay-selvages. The diversified structure of the Comstock vein through its entire mass, and the varied character of the vein-matter, are sufficient to remove all doubts whether it originated in any such way.

All positive and negative evidence which has been adduced in the foregoing pages, goes to show that the Comstock vein possesses more distinctly all the peculiarities of true fissure veins than most other mineral lodes. In many instances it is not easy to decide on the real character of a lode; but this is not the case with the Comstock vein.

MODE OF FORMATION OF COMSTOCK VEIN.

True fissure veins offer a great variety. Every mineral lode may be considered as an individual, peculiar in its nature and differing from all other veins. A review of those silver veins which furnish the larger portion of the present production of silver, would show wide discrepancies, as to the nature of the enclosing rock, the length and width of the veins, the character of the gangue and of the ores, the distribution and quantitative proportion of metals, the structure of the vein-matter and its relation to the enclosing rock, and numerous other circumstances, which it would require too much space to explain separately. It may justly be concluded that the same differences exist as to the mode of formation. Infiltration from above, infiltration from the walls, thermal action, and other processes, have separately been advocated as the sole origin of all metalliferous veins. But the combined experience obtained from different countries, renders it evident that all of these processes have been active more or less simultaneously in the filling of every true fissure vein; and that the differences which such veins exhibit, were occasioned by the predominance of one or the other of them, and by the influence of the enclosing rock.

The Comstock vein has neither been filled from above nor from the sides, as none of the surrounding rocks could have yielded the immense quantity of vein-matter and ore; and had it been formed in this way, the mass would have a

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banded and comby structure, which is by no means observable. The eastern rock may, on account of its extensive decomposition, appear to favor the assumption of lateral infiltration; but this decomposition was effected by ascending currents which have left distinct traces, and which could not have removed any matter in a lateral way. Thermal springs, which are considered by many authorities as the agent which carried mineral matter from below into fissures and to have formed every true vein, would not explain the formation of the Comstock lode. Silica, in such cases, is accumulated around the mouth of the fissures and, though ordinarily removed by denudation, it could hardly be supposed to be so at the Comstock vein as, since its formation, the surface has undergone but slight changes. But, besides, the decomposition of the eastern country, for miles in extent, cannot be explained by the action of thermal springs.

In order to discover the real agent which carried such immense masses of vein-matter from a deep-seated source into the Comstock fissure, we have simply to trace the origin of the latter, and then to observe what processes follow, at the present time, the formation of fissures of similar origin. If these processes are sufficient to produce such results as we observe in the Comstock vein, then it is highly probable that they were instrumental in its formation; and if we succeed in proving that they have left their unmistakable traces all over the country, we may consider the explanation, though theoretical, as founded on a solid basis.

Origin of Fissure.—The Comstock fissure is, of course, of more recent origin than the rocks which it traverses; and as propylite is predominant in the latter, the fissure must necessarily have succeeded it in age. The only event after the outbursts of propylite, capable of producing such powerful action, was the eruption of trachyte, which accompanies the vein at a distance of two miles to the east. As there is other evidence of its intimate connection with the Comstock vein, we may take it for granted that it caused the rending of the fissure. The more immediate cause of the latter is, in similar cases, the production of a constantly-increasing tension beneath the solid crust of the rocks of the surface. As soon as such tension is greater than the resistance offered by the crust, it will cause the rending of the overlaying rocks and give vent to the agencies by which it was produced. Sanidin-trachyte is a volcanic rock and, though it did not pour out from the craters of actual volcanoes, yet it must have been attended by the same phenomena which accompany the outbreaks of lava. Among them

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is the rending of fissures which are occasionally of as great a magnitude as the one under consideration.

Filling of the Fissure.—The process which immediately follows the opening of fissures at or near active volcanoes, is the violent emission of steam. A crevice in this state is called a *solfatara.* It has been proved by Bunsen for the volcanoes of Iceland, by Boussingault for those of the South American Andes, by St. Claire Deville for those of the Canary Islands, and by myself for the tertiary volcanoes of Hungary and Transylvania, that every solfatara, in the course of time, passes through two stages, in the first of which the steam is accompanied by gaseous combinations of fluorine and chlorine; in the second, by those of sulphur; while a third one is ordinarily marked by the emission of carbonic acid and combinations of hydrogen and carbon, at which time the term solfatara is no longer applicable. We have in the elements evolved during the first two periods all the conditions required for filling the Comstock fissure with such substances as those of which the vein is composed. Steam, ascending with vapors of fluosilicic acid created in its upper parts (by the diminution of pressure and temperature, according to well-known chemical agencies) silica and silico-fluohydric acid, the former in solid form, the latter as a volatile gas which acts most powerfully in decomposing the rocks it meets on its course. The chloride of silicon in combination with steam forms silica and chlorohydric acid. Fluorine and chlorine are the most powerful volatilizers known, and form volatile combinations with almost every substance. Besides silicon, the metals have a great affinity with them. All those which occur in the Comstock vein, could ascend in a gaseous state in combination with one or the other of them. They must then be precipitated in the upper parts as metallic oxydes or chlorides, and in the native state. Thus the fissure was gradually filled from its upper portion downwards with all the elements which we find chemically deposited in it. A fissure is ordinarily not stationary after its first opening; but by subsequent action may from time to time widen and frequently contract again. New channels would thus be opened where the old ones were obstructed. If such widening, or opening of an empty space within the matter filling the old fissure, was followed by emanations rich in metallic vapors, then the conditions would be given for the formation of a body of ore of the shape of the newly-opened chasm, which corresponds precisely to most of the bodies of ore in the Comstock Lode. Contemporaneously with the filling of the fissure, the adjoining rock

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would be acted upon by the ascending acid vapors, and its nature by them entirely changed. Cracks would form in it, and be filled with substances similar to those of the vein itself. As the Comstock vein has an eastern dip, and the action of forces manifests itself towards the surface, only the rock on the hanging wall, or the eastern country, would be influenced in this way. Crevices branching off from the main fissure would probably penetrate into the hanging wall, and it may reasonably be expected that deeper working will disclose such branches filled with vein-matter, and probably of ore-bearing character, east of the main body of the vein.

Transformation of Vein-Matter.—A transforming action must necessarily take place from the very commencement of the decomposition of matter in the fissure. Sulphurous acid and sulphuretted hydrogen which were among the escaping gases in the first period, together with combinations of fluorine and chlorine, gradually became predominant, marking the second period of solfataric action. But little more matter could be introduced into the fissure, as the combinations of sulphur with mineral substances are not volatile. Chemical transformation was now the principal action within the vein. Silica is deposited from its combinations with fluorine and chlorine in a gelatinous state, very different in its physical characters from those of the crystalline quartz which fills the vein. It must undergo a solution in water with which, in the form of steam, it was impregnated, in order to assume this character. Metallic oxydes and chlorides were converted into sulphurets, and the presence of antimony caused the formation of sulph-antimoniurets, the principal one of which is stephanite. By such processes, the entire vein-matter was gradually converted from its former condition into that which it presents at this day.

Thus, following simply the mechanical and chemical actions observed in active solfataras, and basing our conclusions on experiments made in the chemical laboratory on the processes of precipitation and transformation which must be effected by them, we are led to precisely the same results which we actually observe in the Comstock vein. The question may still be put as to what was the *origin of the vein-matter*, which in the deep-seated volcanic laboratory was prepared for ascending into the Comstock fissure. As to fluorine and chlorine, they take part in the composition of rocks, but their principal source was doubtless the water which penetrated through the rocks to the region of volcanic activity, and which in the case of active solfataras can alone explain the contin-

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uous emanation of volumes of steam. Though the sea, at the time of the formation of the Comstock vein, was far distant, yet the waters of the adjoining basins were, as they are to-day, highly charged with the same salts as are dissolved in sea-water, among them chlorides and fluorides. Fluorine and chlorine, therefore, had the same origin as they are supposed to have in active solfataras. As to the source of the mineral substances, we have to look for the action of those elements on the surrounding rocks. Silica was offered in unlimited quantity, particularly in the trachytic rocks. Every silicate is easily decomposed by fluorine, fluosilicic acid escaping in a gaseous state while some solid residuum remains. For the metals we have to account in the same way, considering the vast quantities of rock which in the depths of the solfataras could be acted upon by the acids. Silver appears, from recent researches, to form, in very small quantity, a constituent part of every rock, and gold probably enters in still more minute quantity into their composition, while other metals are present in larger proportion, and iron especially forms a considerable per centage in the composition of all rocks. But even those which are present in so small a proportion as almost to escape detection by chemical analysis, may be concentrated, if acted upon by such elements as have most affinity to them, and then carried by them into channels where, when exposed to other influences, they are deposited. It is a fact worthy of notice that there is scarcely a single chemical agent, excepting fluorine and chlorine, which would not carry metallic substances into fissures in exactly or nearly the reverse quantitative proportion from that in which they occur in silver veins. Iron and manganese are not only more abundant in rocks but also much easier attacked and carried away by acids, than silver and gold. The proportion of these to the former ought, therefore, to be still smaller in mineral veins than it is in rocks, and lead and copper ought to be more subordinate, if their removal from their primitive place had been effected by other agents than fluorine and chlorine. Only these two will first combine with those metals which are most scarce in rocks and relatively most abundant in silver veins; and they are probably the only elements which have originally collected them together into larger deposits, though these may subsequently have undergone considerable changes, and water may have played altogether the most prominent part in bringing them into their present shape.

Dynamical Action in the Vein.—The rending of the fissure was the first dynamical action in the history of the Comstock vein. It continued, as men-

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tioned before, in repeated rewidening and partial reclosing. Another dynamical process was the separation of fragments from the hanging wall of the fissure. Small fragments fell into it during the formation of the vein-matter and caused its brecciated structure, while larger ones were separated by the formation of fractures and slid down until they met resistance. Every fissure of active solfataras is closed on the surface by similar fragments broken off from the sides of the fissure, and one may walk on solid ground over the chasm from which steam issues hissing and roaring, escaping from between the rocks and feeding boiling cauldrons. There is no difference between these obstructions and those in the upper part of the Comstock fissure. Other dynamical changes which are still going on constantly, are manifested by the clay-selvages along the walls and the clay-seams in the body of the vein. They indicate a sliding motion of the vein-matter on the walls, and of different portions of the former on each other. Few veins present such plasticity of the vein-matter as the Comstock Lode possesses, a circumstance which on one side facilitates mining extraordinarily, on account of the loose nature of the quartz, while on the other part it is the most serious nuisance in mining, as it causes the rapid breaking and caving of old works. Drifts in clayey matter cannot be kept open by the strongest timbers, those of a foot square in thickness being frequently broken within a few days. The constant movement in the vein may also be witnessed where clay-seams are cut by drifts; after some time the rock on one side is lowered considerably. Mining works probably promote this slow but incessant motion in the body of the vein, since they open outlets for the water, which can percolate the vein-matter freely and diminish its substance by its dissolving power.

Additional Proof of former existence of Solfataric Action.—Though it seems that the Comstock fissure was the principal theater for the emission of steam and all those phenomena which may be comprised by the name of solfataric action, yet the latter left its traces over a wide extent of the adjacent country. The entire belt of rounded hills extending east of the vein for two miles, to the foot of the trachytic range, shows its effects very conspicuously. It consists of propylite; which, however, can scarcely be recognized on account of the complete decomposition it has undergone and which has transformed it into a clayey rock of red and yellow color, but still showing distinctly the enclosed crystals of feldspar and hornblende. It is traversed by numerous crevices from which the decomposition originated, and shows everywhere evidences of vertically-ascending

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currents which caused it. Whoever has seen active solfataras, will be struck by the resemblance of the chemical action on the surrounding rocks to that displayed in the region east of the Comstock Lode. Near some of the crevices the decomposed rock is strongly impregnated with silica, producing the ranges of red-colored bluffs which accompany the Comstock vein to the east, and which have been partly located as outcroppings of veins, while at about two miles distance real metalliferous veins occur, promising in their outcrops, but not yet explored. Besides this belt, the former action of solfataras is plainly visible in many parts of the country. The formation of the Comstock vein is but one of its manifestations.

CONTINUITY OF THE COMSTOCK VEIN IN DEPTH.

The problem which above all others occupies at present the minds of miners, stockholders, and speculators in Washoe, is, whether the Comstock Lode will continue in depth, and, if it does, whether it will be productive. And these questions are indeed of the highest importance for the future of the country, and ought so much more to be considered with care, as on their solution depend the means which will have to be applied for securing future prosperity and profits.

It was proved in the foregoing pages that the Comstock Lode presents in all respects the character of a true fissure vein, and these in such perfect degree as but few veins of this class exhibit. It was furthermore proved that the mode of its formation can only be explained in one way, namely, by solfataric action connected with the outbursts of trachyte. No theory but this is able to explain the origin of the vast quantities of vein-matter, the profuse diffusion of ore through it, the abnormal quantitative proportion of the metals in the ore, the thorough decomposition of the eastern country for two miles in width, the mode of distribution of the ore in the vein, and the formation of the "horses" which obstruct it in many parts. As the creative forces acted from below, they must have found an open way for the communication of the laboratory below with the place of deposition in the upper portion of the vein. No sound mind can therefore doubt the continuance of the fissure, and therefore of the vein, in depth.

MODE OF CONTINUANCE IN DEPTH.

It is much easier to come to definite conclusions in regard to the question, whether the Comstock Lode continues at all in depth, than to state the most

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probable mode of its continuance. Our deductions as to this subject cannot but be hypothetical, however numerous and well founded the facts and laws may be on which they are based. We may consider the question from different points of view, partly in reference to the structure in general, and partly to the ore-bearing character.

Inclination.—It appears that the real inclination of the Comstock vein coincides with that of the western wall, which is remarkably constant for a distance of nineteen thousand feet on the course of the vein, wherever it has been explored, and for about one thousand feet in vertical extent, from its highest outcrops to the deepest mining works. The angle at which it dips to the east, varies from thirty-eight to sixty degrees, the lower figures being the usual ones near the surface, the higher ones at a moderate depth, while in the lower works the inclination is again forty-five degrees. There is but one reason in favor of the assumption that the lode may straighten out to an almost vertical position. This is the occurrence of "horses" identical with the rocks forming the western country, and the vertical position of the plane of division between these horses and those derived from the eastern country, wherever such difference exists between both sides of the fissure. The assumption that the fissure originally followed this vertical dividing plane, would well account for all the phenomena presented by the "horses." But this argument is not strong enough to militate against the regularity of the inclination of the western wall, moreover as the eastern wall was by the mining works proved to make the previously-mentioned bend, and to assume finally, in depth, an inclination parallel to the western wall. There is another argument corroborating the theory of the permanency of the present dip of the vein of about forty-five degrees to the east, which, from a geological point of view, is more conclusive. As mentioned before, the propylitic rocks for two miles east of the vein have undergone a decomposition which, from its nature, must be ascribed to the former action of solfataras. There can be no doubt, that the currents of steam and vapors, which left their traces particularly on the sides of numerous vertical fissures, emanated from one common source. Since the concentration of solfataric action must have been in the Comstock fissure, where its results are most evident, it appears that this has been the immediate source, and through its inclined hanging wall branched off all those ramifications which spread the decomposing agents through the overhanging rock; this at least is manifestly the case in the lower works, where

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crevices filled with quartz and clayey matter ascend vertically through the hanging wall, but frequently do not rise to the surface.

Width of Vein.—The indistinct character of the eastern boundary of the Comstock vein often renders the determination of its width difficult. Near the surface it is ordinarily five hundred to six hundred feet, and on American Flat exceeds these figures. With increasing distance from the surface the vein gradually contracts, to that certain depth where the eastern wall begins to descend parallel to the western one; from thence downwards it begins to be more constant. The real width of the vein cannot therefore be determined before this depth is reached. In general, the parallelism of the walls commences in the northern mines at a higher level than in the southern ones. Five hundred feet may be considered as the average depth at which it is first well marked; but on American Flat it appears to be several hundred feet more. As far as the vein at this depth has been explored from wall to wall, it forms a channel of great regularity and about one hundred to one hundred and twenty feet in width (at right angles to the inclination,) though at some places it expands beyond this figure, and at others contracts. South of the Chollar-Potosi mine, the vein is nowhere contracted in width; but north of it, the walls frequently come together. Such places must necessarily occur in an inclined vein of some magnitude, since the hanging wall, during the long periods of the filling of the fissure, required some support. The walls of every true fissure vein are uneven planes. The downward movement of one side of the fissure on the other, at the time of the formation of the vein, caused protuberances of one wall to meet such of the other and concave places to come opposite each other. This is the reason why every large fissure vein is liable to repeated expansions and contractions, though the former prevail largely over the latter. It is to be expected that the Comstock Lode will exhibit the same features in its downward course to indefinite depth, as it also has done heretofore, though its general width will probably remain nearly equal to that which it possesses in the lowest works.

"*Horses.*"—The formation of large "horses" is, from the nature of their origin, more peculiar to upper than to lower levels, since their breaking down from the hanging wall will in every fissure be most apt to take place where the latter is of comparatively inferior thickness, than where it is hundreds or thousands of feet wide. But small fragments may separate from it at any depth, and their quantity will chiefly depend on the nature of the rock and the power of the

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decomposing agents. It was mentioned before, that the action of the latter was exceedingly violent in the Comstock fissure, fluorine, chlorine, and steam being the principal elements by which it was effected. It is therefore highly probable that the bulk of small fragments will be very considerable at lower depths, and that this will cause the appearance of brecciated vein-matter to great extent, besides forming larger accumulations of barren nature, which will principally be above the places of contraction. This may already be observed in the Ophir mine, in the deepest works at the present time.

Enclosing Rock.—It is not likely that the country-rock adjoining the vein on either side will, in depth, undergo any changes, other than such as may be occasioned by different degrees of decomposition or by an increase of some of them in extent. The structure of the country indicates that the meridional Mount Davidson range existed at the time when the eruptions of propylite formed an addition to the mountain mass on its eastern side, and that the steep slope of the former continues below the rounded hills of the latter. Probably the fissure followed the plane of division of the ancient Mount Davidson rocks with the more recent masses of propylite, as offering less resistance to the tension below than the rending of the solid mass of one kind of rocks would have done. Only where the old slope deviates from a straight line, the tertiary rocks appear to have filled the depressions, and the fissure to have intersected them. Yet the ravines in the old mountains, which formerly were the same as at present and descend below the propylitic covering, have had some influence, since the vein is known to make concave bends through them. This influence will, therefore, most likely be perceptible to great depth, though it may not always be as unfavorable for the ore-bearing quality of the vein as it has been in the upper levels. If any change as to the enclosing rocks should occur in depth, it is probable that propylite will disappear on the western side and syenite predominate there more and more.

Selvages.—All the evidences in the upper levels justify the expectation that the foot wall will continue with its smooth and regular clay-selvage, while the irregularity and indistinctness of the eastern side will not diminish, but rather increase as its true character as hanging wall will become more conspicuous. The vertical sheets of clay which have from time to time been cut in the adits east of the vein, rise undoubtedly from the hanging wall. Every one of them, when struck at a lower level, will in its course be considered as east-wall, until

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another one farther to the east will be found. This periodical change of opinion is already now observable in the deeper mines. Clay-seams within the body of the vein will probably diminish with the increase of unity in inclination. Those which are at present observable at upper levels, are particularly occasioned by the vertical position of the vein-matter, which of course facilitates sliding motions. Larger accumulations of clay will especially continue near the old ravines.

Ore-bearing Character and Distribution of Ore.—Some unfavorable developments made recently on the Comstock vein, have induced even those who believe in its continuity, to have some doubt in regard to its carrying any ore in depth. The question is of great importance, and one in regard to which one may easily arrive at too sanguine views if mines are "in bonanza," and just as easily at too unfavorable results when they are "in borasca." A short review of some facts observed in other silver mines may assist us in drawing conclusions for the Comstock vein.

In no branch of mining are the vicissitudes of this industry so conspicuous as in silver mining. Princely fortunes have been made by it in the shortest time, and equal amounts spent in vain in search of fortunes. The history of the Mexican mines, as chronicled by Humboldt and Ward, furnishes remarkable illustrations; but they would possess a still higher degree of interest if an equally able historian could be found in modern times, who might add those developments which have taken place during the present century. We are told of mines which, after having yielded immense wealth, were abandoned because no more profits could be obtained, and then, after a long lapse of time, were reopened by enterprising individuals, and anew poured out treasures from below where they had been worked before, then were left again, and successfully reopened a third time. The causes of abandonment were either the deterioration of the ore, or the impossibility of making the returns exceed the expenses of keeping the water down, or lawsuits, or, finally, political circumstances. The success of reopening was, in the two first cases either due to the improvement of the ore at some lower level, or to the introduction of cheaper modes of drainage, partly by improved machinery and partly by adit-levels.

The Valenciana mine on the Veta Madre of Guanajuato, was opened in 1760 on a part of the vein on which some work had been done in the sixteenth century, and which afterwards had been neglected as unpromising for almost two

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centuries. In 1768 a rich "bonanza" was struck at a depth of two hundred and forty feet, from which $1,500,000 were extracted annually. Still from 1788 to 1810 the yearly produce averaged $1,383,195. A town of seven thousand inhabitants was built near the mine, and thirty-one hundred people were occupied by the latter. A large octagonal shaft was sunk to upwards of two thousand feet, and the mine explored by it in lower parts. But the rich ore extended only to the depth of twelve hundred feet, below which it was then too poor for extracting. In 1810 the mine filled with water. Fifteen years later the Anglo-Mexican Company, with a considerable outlay of money, freed the mine of water, but the ores gave no profit, on account of the expenses of keeping the water down. It is now owned by the United Mexican Company, and for a number of years has yielded immensely by the large amounts of low grade ores which fill the vein.

The Veta Grande, at Zacatecas, which from 1548 to 1832 yielded about $666,000,000, occurs in propylite, as does the Comstock Lode, and has a similar structure, the vein branching out towards the surface and descending at an angle of about forty-five degrees. Its width is inferior to the Comstock vein, being generally not more than from one to thirty-three feet, and only at one place increasing to eighty feet. It has clay-selvages and encloses large fragments of country-rock. The ore in the upper levels was concentrated in chimneys and rich, but with increasing depth it became poorer, though at the same time it was distributed through a much larger extent of the vein. The ore for some time could not be worked with profit, but at present the production of Zacatecas has again reached a very high figure.

In these two instances the ores are poorer in the lower portions of the lode, but more equally distributed, and it is the immense quantity of low-grade ores which causes its great productiveness. It is noteworthy that the character of the ores changes in no other respect. They remain true silver ores through all levels. Many other mines offer the same conditions, particularly those in the central part of Mexico. It is different in the northern provinces. The silver mines there are famous for the large amounts of native silver which they produced near the surface, and the quantity of rich ores which were raised from them. They too have poorer ores in depth, but this poverty is due to the increasing predominance of lead over the silver in the veins. The same is true of the silver mines in the Carpathian mountains, all of which are in propylite

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and resemble the Comstock vein in many respects. The vein of the Grossgrube in Felsobanya is almost its counterpart. This mine as well as those of Schemnitz are said to have yielded immensely in former times, though worked with imperfect processes. Extensive chimneys of ore have been entirely removed by the Romans. In depth the ore is exceedingly poor, so as to yield but a small profit with the economical mode of working proper to European countries. But this deterioration is chiefly due to the prevalence of the ores of lead and copper in lower levels, true silver ores being of rare occurrence. At the same time the ores become more equally distributed through the entire vein-matter, though they still form in it small seams and bunches.

Other mines retain an equal yield of silver at every depth. Those at Freiberg, though having their bonanzas at different levels, have on the whole rather improved with an increase in depth. Those of Kongsberg, in Norway, had their temporary bonanzas as far down as eighteen hundred feet, the lowest level reached, and have in later times yielded more profits than formerly. Those of Catorce and several other places in Mexico, show likewise no decrease in yield, and have excellent ores at eighteen hundred and two thousand feet in depth. Many other mines of the same nature could be mentioned.

It would occupy too much of our space to enter more fully into the details of other argentiferous veins. If we proceed to compare the Comstock vein with those best explored, it is evident that it differs in nature from a certain class of narrow veins, which, as those of Freiberg, Kongsberg, Chañarcillo in Chile, Pasco in Peru, Catorce in Mexico, and Austin in Nevada, fill a number of small fissures, which are either parallel or intersect each other, and which exhibit in depth nearly the same character and richness as near the surface. It presents, on the contrary, all the characters of a second-class of silver-veins which are prominent on account of their magnitude and unity, and exhibit wherever they occur, one great mother-vein or "veta-madre," surrounded in most instances by some smaller veins of little or no importance. To this class belong the veins of Schemnitz and Felsobanya in Hungary, the Veta-Madre of Guanajuato, the Veta Grande of Zacatecas; while the veins of Potosi in Peru and the Biscayna of Real del Monte in Mexico have to be referred more to this than to the former class. Notwithstanding their small number, these great mother-veins furnish by far the greater portion of the silver produced throughout the world. They resemble each other in many points. All of them fill fissures of extraordinary

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width and length, and appear to be of very recent origin, and also to be intimately related to volcanic rocks, by which they are accompanied. Although the laws which govern the distribution of the ore differ more or less for each vein, yet all of them have been found to be highly metalliferous to whatever depth explored; and it appears that a nearly equal quantity of silver is with most of them contained in each level (the vein of Guanajuato being an exception to this rule.) It may be inferred that this will continue to be the case to an indefinite depth. There is, however, a marked difference in the concentration of silver, ores of extreme richness being usually accumulated in limited bodies in the upper levels, while in depth similar bodies recur, greater in extent, but consisting of lower grade ores. This is one of the principal reasons why, on all the veins mentioned, mining in upper levels has been so highly remunerative compared with the profits derived from deep working. Each ton of ore costs there but little to extract, and yields a large amount of metal, while raising the same weight from greater depth is more expensive, and at the same time a smaller amount of bullion is realized. The history of the Mexican mines is the best illustration of these relations. In former centuries Counts and Marquises have been made by the King of Spain whenever fortune enabled a single individual to accumulate enormous wealth in a few years. Mining, then, was confined to rich ores within a few hundred feet from the surface. In the present century, since greater depths have been reached, the Spanish Crown, if it had still the scepter of Mexico, would scarcely have found an opportunity of bestowing equal honors on fortunate mining adventurers, notwithstanding the unabated enterprising spirit of the population, and the increased facilities of raising the treasures. And yet, the production of the Mexican mines has anything but decreased. It appears, on the contrary, that it has never been as high as at the present time. Humboldt states that vastly the majority of the annual production of Mexico has through all times been derived from the mother-veins alluded to above; and still at this day, they furnish at least three-fourths of it, though each of them has repeatedly been abandoned as unprofitable. They would be inexhaustible sources of wealth, if the increase of expenses attending the growing depth did not put a limit to all profitable mining.

The equality of produce of the Mexican mines is probably partly due to the prevalence of true silver-ores through all levels. The Hungarian mines offer less favorable conditions, as the ores, on account of the previously-mentioned

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increase of lead and copper in depth, undergo a real deterioration. Yet they have evidently had at upper levels their concentrated bodies of rich ore. Such have been extracted at Schemnitz within the time of historical record, while their former existence at Felsobanya may be inferred from the shape and character of the old Roman works near the out-croppings.

Let us now return to the Comstock vein, the "Veta-Madre" of Washoe, and examine what conclusions as to its future we are justified in drawing from the present condition of the explorations. In the first place, we have to mention the fact that the ores through all the levels explored, retain the character of true silver-ores which they had near the surface. The amount of lead, copper, iron, and zinc has never been large in the Comstock ores, and these metals preserve now, at the lowest levels, nearly the same relative proportion as formerly. Their increase, especially of lead, would be the most unfavorable indication for the future of the Comstock Lode, as, besides the growing difficulty of metallurgical treatment, the conclusion would be justified, that lead ores would more and more replace those of silver, and the limits of profitable productiveness would soon be reached. But, as it is, no deterioration is to be expected, even if an impoverishment takes place. It thus approaches in its ore bearing character the great mother-veins of Mexico, and is different from those of Hungary.

But even the reasons for an impoverishment are by no means so evident as might appear at first sight. There have been, it is true, bonanzas near the surface, which surpassed in richness all those worked upon in later times. As such may be mentioned the bonanzas of the Ophir, the Gould and Curry, and the western body of ore in Gold Hill. Their richness and the facilities of their extraction co-operated in making the latter exceedingly profitable. Yet the production of the Comstock vein did, at the time when it was solely derived from these surface-bonanzas, not reach the figure it attained after the exhaustion of their principal portion. One of the reasons is, that then the ore was concentrated within narrow limits, while, as a greater depth was attained, the distribution of the ores was much more general, though their standard was lower. New bodies of ore had been discovered, commencing at a depth of from one hundred and fifty to three hundred feet below the surface, such as the continuous sheets of ore in the eastern part of the lode in the Gold Hill mines and the Yellow Jacket, and the similarly-constituted one in the Chollar-Potosi. None of them contains, excepting a few narrow streaks or bunches, ores of equal richness with

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those of which the surface-bonanzas were composed. But their extent so far exceeds that of the latter, as to make up, by the increased amount of daily extraction, for the inferior yield. The profits of working are, of course, greatly diminished.

These bodies of ore have continued to the deepest levels reached in the Comstock mines, varying in width and extent, and also in their yield. The latter did not increase, but in some instances, as in the southern part of Gold Hill, decreased with the growing width of the deposit, while in others no material change is perceptible. Few new bodies of ore made their appearance below the level of three hundred feet. Foremost in importance among them are two bodies discovered at seven hundred feet below the surface by the Hale and Norcross works, one of which is on ground supposed heretofore to be unproductive.

Considering these facts exhibited by the Comstock vein itself, and comparing with them what is known about similar argentiferous veins, we believe to be justified in drawing the following conclusions:

1st. That the continuity of the ore-bearing character of the Comstock Lode in depth must, notwithstanding local interruptions, be assumed as a fact of equal certainty with the continuity of the vein itself.

2d. That it may positively be assumed that the ores in the Comstock Lode will retain their character of true silver ores to indefinite depth.

3d. That it is highly probable that extensive bodies of ore equal in richness to the surface-bonanzas, will never recur in depth.

4th. That an increase in size of the bodies of ore in depth is more probable than a decrease, and that they are more likely to increase than to remain of the same size as heretofore.

5th. That a considerable portion of the ore will, as to its yield, not materially differ at any depth from what it is at the present lower levels; while, besides, there will be an increasing bulk of low grade ores. We are led to this supposition by the similarity in character of all the deposits outside of the rich surface-bonanzas, and the homogeneous nature which almost every one of them exhibits throughout its entire extent.

6th. That the ore will shift at different levels from certain portions of the lode to others, as it has done up to the present time. More equality in its distribution may, however, be expected below the junction of the branches radiat-

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ing towards the surface, when the vein will probably fill a more uniform and more regular channel. Some mines which have been heretofore almost unproductive, as. the Central, California, Bullion and others, have therefore good chances of becoming metalliferous in depth. But throughout the extent of the vein it is most likely that the portion which lies next to the foot wall will continue unproductive, as it did from the surface down to the lowest works, while the entire portion between it and the hanging wall must be considered as the probable future source of ore. As remarked in the foregoing pages, it is also probable that repeatedly, in following the lode downward, branches will be found rising from its main body vertically into the hanging wall and consisting of clay of quartz. Many of them will probably be ore-bearing. Such bodies of ore should be sought for, at all the mines, in what is generally supposed to be the eastern country. Experience in upper levels would lead to the supposition that such eastern bodies might carry richer ores than the average of the main portion of the vein.

7th. That the intervention of a barren zone, as is reported by good authorities to occur at the Veta Madre of Guanajuato, at the depth of twelve hundred feet, is not at all likely to be met with in the case of the Comstock Lode. The argument which we have to adduce for this conclusion, has some weight from a geological point of view. It is a well-known fact that the enclosing rocks have usually great influence on the quantity and quality of the ores of certain metals in mineral veins, and that a rich lode passing into a different formation frequently becomes barren or poor. At the Veta Madre of Guanajuato, a sudden decrease in the yield of the ore, at the depth of twelve hundred feet, attends the passage of the lode into a different formation, which from thence continues to the lowest depth attained. No such change can ever be anticipated for the Comstock Lode, since the structure of the country seems to indicate the continuity of the enclosing rocks to an indefinite depth.

In winding up these considerations, we come to the positive conclusion, that the amount of nearly fifty million dollars which have been extracted from the Comstock Lode, is but a small proportion of the amount of silver awaiting future extraction, in the virgin portions of the vein, from the lowest levels explored down to indefinite depth; but that, from analogy with other argentiferous veins, as well as from facts observed on the Comstock Lode, the diffusion of the silver through extensive deposits of middle and low grade ores is far more probable than its accumulation in bodies of rich ore.

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MEANS OF SECURING FUTURE PRODUCTIVENESS.

The main object for those engaged in mining on the Comstock Lode should be, to derive the highest possible profits from the exploration of the mines, that is, to devise means for reducing the expenses and improving the methods of reduction. In both these respects improvements have been made heretofore at equal rate with the decrease in the yield of the ore, and profits are now earned from ores which are much poorer than any worked in former days. Yet, by the constantly-increasing expenses of pumping, hoisting and keeping the mines in working order, these profits will soon disappear and losses be incurred if no further reduction of expenses takes place. In speculating as to the means required for attaining this end, we have to start from as unfavorable a basis as possible and to employ such as will be applicable even in the possible case of an impoverishment of the ore in depth.

The Comstock mines have this great advantage, that sinking and driving are relatively cheap, owing to the soft nature of the quartz and country-rock. This character will probably not change at lower levels. The best system of mining will therefore be that which makes the best use of this advantage and, at the same time, meets most perfectly and with the least expense the disadvantages resulting from the same quality of the rock. Such a system, which is very different from that formerly in use, is being more and more adopted. The former plan of removing first all the ore in sight, and of commencing exploring work in other parts of the mine only after the complete exhaustion of the former, when the reluctant stockholders are forced to pay for the doubtful success of the work, is not yet abolished; but in some mines is giving way to a more sensible system of exploration. Even if stock-speculation, the greatest enemy of legitimate mining, should hereafter still exert its evil influence on the management of the Comstock mines, yet those other improvements will not fail to act in a beneficial way. So, too, the increasing knowledge of the nature of the Comstock vein has led to an improved system of working. The soft nature of the eastern country compared with that of the hard western rocks, has taught that shafts can only be sunk profitably in the former, and never ought to be allowed to penetrate into the latter. The dip of forty-five degrees to the east makes it a matter of course, that a shaft near the outcroppings will reach sooner the hard foot-wall than one which is constructed farther east. Much money would have

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been saved if this experience could have directed former operations. Henceforward the working of the mines will be in great degree governed by this idea. The gentle slope to the east, on the surface, of the eastern country facilitates greatly this method of exploration.

Yet all these improvements cannot prevent the profits derived from ores of the present average yield becoming, in course of time, gradually less and at last insufficient to cover the increasing expenses. Shafts must be sunk to greater depths; and the power required for hoisting the ore increases in a rapid ratio. It will be more and more difficult to secure thorough ventilation, and to get rid of the heat and moisture of the air in depth. But more than all this, the water in the mines will be a growing impediment. The power of pumping-machinery is being increased constantly, and the amounts paid for keeping the mines dry have already attained a high figure. At the same time other heavy expenses remain stationary, such as hauling the ores to the reduction works. The cost of reduction on Carson river, by water power, is not more than five dollars per ton; but is increased to eleven dollars by the cost of hauling the ores from the mines. The mills in the vicinity of the mines are worked by steam power, and, though hauling to them costs only one dollar to one dollar and fifty cents a ton, yet the aggregate expense is the same as in the former case. The total costs per ton at the mine, if it is very productive, are not less than seven dollars per ton, and as in most cases a considerable profit has to be paid to the owners of reduction works, the lowest limit of profitable working is a yield of twenty-five dollars per ton, with the application of an imperfect method of reduction, and no reasonable profits can be expected from ores which yield less than thirty dollars per ton.

If some means could be devised to lower the expenses of freight to Carson river, where, besides the considerable water-power, steam-power is much cheaper than near Virginia and Gold Hill, and if at the same time the expenses of working the mines could be reduced, the extraction of such ores as are far beneath the present average would then become profitable, and the gains from the latter would greatly increase.

The only possible way of attaining these results is the construction of a deep adit-level or "drain tunnel," as it is called by the Washoe miners. There is probably no silver mine in the world which offers so great facilities and inducements for the performance of such a work. It is proved that an adit-level of

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not more than twenty thousand feet in length would strike the Comstock vein about one thousand nine hundred feet vertically below its outcroppings. The construction of the work would be comparatively easy, as the rock to be perforated is far superior to the average of rocks through which adit-levels have been constructed in other countries, in respect to the ease with which they can be excavated. The importance of "drain tunnels" for mines in general has lately been demonstrated repeatedly and illustrated by numerous examples from other countries, in reference to the execution of the work of this kind contemplated for the Comstock vein. I will therefore not dwell here on this subject, but will simply state the various reasons why it appears to me to be the only way of securing the future profitable productiveness of the Comstock mines, and will try to show what additional benefits may be derived from the speedy execution of this work.

1st. The greatest benefit would be, the drainage of the mines, which, by branches north and south, could be effected throughout the whole length of the vein. The amount which is expended for it at the present time will, with the further application of pumps, increase constantly, and so absorb alone all the profits. Adits at upper levels drain usually but a small portion of the vein, as intervening clay-seams retain the water in reservoirs, which have to be tapped in order to be drained. This inconvenience will doubtless cease with the turn of the vein to its regular dip and course, as the clay-seams within the body of the vein will then probably only continue in or near the ravines. Every portion between two ravines will have most likely to be drained by a separate branch from the adit.

2d. An adit will allow work to be continued to the unusual depth of at least twenty-four hundred feet. Exploration and exploitation will be equally easy and inexpensive as the principal impediments to deep working will be removed.

3d. The removal of the ore, in particular, from the mines will be easy, expeditious, and cheap, since no more hoisting by application of steam-power will be required, but all the ore can be carried out on cars through the adit; the inclination of the lode of forty-five degrees will make the dumping of the ore into the adit-level convenient.

4th. The adit will give vent to a perpetual flow of water. It would be hazardous to undertake to calculate its amount. But if it is taken into consideration, that the water from a few adits above and back of the outcrops of the

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Comstock vein gives at present a sufficient flow for the wants of Virginia City and Gold Hill, and the adits to the Comstock mines at high levels furnish an additional supply for the requirements of all the reduction works near Virginia, Gold Hill, Silver City, and Johntown, a stream of greater volume may be expected from the depth of nineteen hundred feet, and it will be considerably increased by the drainage of the country between the mouth of the adit and the Comstock vein. As there is a difference in elevation of about two hundred feet between the former and Carson river, the water may be made available for the erection of reduction works all along its course after it has left the adit. The cars carrying the ores from the mines may empty their contents immediately at the different mills, and thus the amounts of freight be avoided, which at the present contribute to render the reduction of the ores expensive. Steam-power on Carson River, as aforesaid, is cheaper than in the vicinity of the mines, but will scarcely be required to great extent on account of the water-power of Carson river.

5th. A thorough ventilation of the mines will be effected by the adit, and the working thus accelerated and facilitated, and the decay of timbers diminished.

6th. A very important result of the construction of the adit would be the thorough exploration of the Comstock vein in those parts which up to the present have been unproductive. On all the mines between the Ophir and Gould and Curry, work has been discontinued and will probably not be resumed for a long time. North of the Ophir, where the character of the vein and the bold outcroppings on Cedar Hill appear, from analogy, to justify expectations of success, the explorations have always been very limited, and stockholders will soon be deterred from further investment by the expense required for deep explorations, if favorable indications at the present levels should not encourage them more than heretofore. The most unlucky portion of the whole Comstock vein has been American Flat, of which stock-speculation took a fatal hold. About one hundred locations were made all over the broad belt in which the several branches of the Comstock vein come to the surface, and quite as many "mines" opened. Far more than one million of dollars has been expended on these, but no decided result was obtained, on account of the scattered and superficial character of the work. The same outlay of money spent in a thorough and systematic exploration at one place would have sufficed for a thorough development, and the nature of that part of the lode would be known. But there is

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no prospect of such a work being undertaken. A complete discouragement followed suddenly the greatest excitement, and the mines have been almost entirely abandoned. Other reasons will retard the resumption of work, as, besides the expenditure which the adjustment of the numberless conflicting titles would require, the indications at upper levels are not encouraging. The vein is unusually wide, the diverging branches being about one thousand feet distant on the surface. The place where both walls descend parallel to the east, will therefore be at greater depth than in other portions of the vein, and exploring work ought to descend at once to about eight hundred feet. The deep adit will not only explore all these unproductive parts of the vein at a depth of nineteen hundred feet, but also facilitate the examination of its entire body from that depth to the surface.

7th. Another advantage of the adit will be the exploration of the country from its mouth to the Comstock vein, which may possibly result in considerable profits. The line of the proposed adit is crossed by two belts of metalliferous veins, one to the east of the trachytic range, the other to the west of it. The former is at a short distance from the mouth of the tunnel, the other about two miles west of it. The latter will be cut about sixteen hundred feet below the surface. It contains several veins, among which the Monte Cristo, Occidental, and St. John are best known. The belt continues to the vicinity of Silver City. At many places the outcrops were found rich in gold and silver, and at present some ore from them is said to be worked with profit. These veins have never been thoroughly explored, but the appearance of their outcrops justifies the expectation of their ore-bearing character in depth.

The disadvantages of working the Comstock mines with the present system to considerably greater depth, compared with the great benefits which would result from the construction of a deep adit, are so self-evident as indeed to make the speedy execution of this work a question of vital importance to the future productiveness of these mines. In the former case, the treasures buried in the unexplored depths of the vein will be valueless, in the other they will be a lasting source of wealth, for the owners of the mines, for the population of Washoe, and that portion of the community at large which depends more or less on the products of the Comstock vein. The amounts poured out by the latter to the imperfectly explored depth of five hundred feet, besides those which are still known to exist above this level, are such as to render insignificant the disburse-

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ment required for the execution of a work which will not only thoroughly explore the entire vein at a deep level, but allow the works to descend two thousand feet below their present lowest levels with comparative ease. The future yield of the mine, as argued before, is not to be expected from other concentrated bodies of rich ores, but from large accumulations of middle-grade and poor ores, which cannot be profitably extracted but after the completion of a deep adit. We consider its execution as the only possible way of securing the future productiveness and profitable working of the Comstock vein.

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Report of the Mechanics' Institute,

OF SAN FRANCISCO, CALIFORNIA.

ADOPTED UNANIMOUSLY AT THE REGULAR MEETING OF APRIL 4th, 1867.

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REPORT ON THE SUTRO TUNNEL.

The Mechanics' Institute, of San Francisco, California, on the 7th of March, 1867, *appointed a special Committee, consisting of* WM. T. LEWIS, *Chairman,* ARCHIBALD COOPER *and* P. M. RANDALL, *for the purpose of investigating the Sutro Tunnel Project, who made the following report, which was unanimously adopted at the regular meeting of the Association, held April 4th,* 1867:

DISCOVERY OF SILVER IN NEVADA.

In June, 1859, Peter O'Reilley and Patrick McLaughlin, while engaged in gold washing on a spot which is now the property of the Ophir Company, discovered a heavy black substance, which, upon examination, was found to contain sulphurets of silver of the highest value.

It was ascertained that this substance was a portion of the vast deposit of silver and gold-bearing ore, now known as the Comstock Lode, so called from a miner named Comstock, interested in the first purchase of the adjoining ground.

An excitement unparalleled since the first discovery of gold in California followed; speculators and miners from California crossed the Sierra Nevada Mountains, and rushed to the new mines. Locations were made for miles on the supposed course of the lode, and the flourishing towns of Virginia City and Gold Hill sprung up; the former named after one James Finney, a native of the State of Virginia, who was known among his fellows by the *soubriquet* of "Old Virginia."

Under rules formed by the miners, similar to those long in use in California, each miner was allowed to locate 200 feet on the length of the lode. These locations were afterwards transferred to companies, and comprises the ground now belonging to the Ophir, Mexican, Gould & Curry, Savage, Hale & Norcross, Imperial, Yellow Jacket, Crown Point and many other companies not so well known.

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YIELD OF BULLION.

These mines have now a world-wide reputation; the yield of the precious metals from the Comstock Lode far exceeds that of any other locality.

The annual produce for the past five years has been, in round numbers, as follows:

1862	$ 4,000,000
1863	12,000,000
1864	16,000,000
1865	15,000,000
1866	16,000,000
Total produce in five years	$ 63,000,000

The total annual production of silver in the world in 1854 is stated by Professor Whitney at $47,443,200. The bullion obtained from the Comstock Lode in 1866 is, therefore, equal to more than one-third in value of all the silver produced in 1854. Mexico, in its most flourishing days, from 1795 to 1810, produced an annual average of $24,000,000 from several thousand mines. After 1810, when the Revolution took place, the yield of the mines fell in some years to as low a figure as $4,500,000, but the average from 1810 to 1825 shows $10,000,000. At the present time the entire product of Mexico does not exceed that of the Comstock Lode.

The celebrated mines of Potosi averaged about $4,000,000 per annum for 300 years; those on the Veta Madre (mother vein) of Guanajuato, about $3,000,000 for an equal period, and the mines of the Real del Monte Company, on the Biscanya vein, in Mexico, $400,000 for the last 110 years, or a total of $44,000,000—a less amount than has been obtained from the Comstock Lode in the last three years.

PROFITS IN MINING.

The immense yield of bullion from the Comstock Lode will lead one to suppose that the profits realized by the owners have been proportional to the yield, but this has not been the case.

It is true that the value of bullion obtained by some companies has greatly exceeded the current expenses; as, for example, the Gould & Curry, the net

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profits of which amount to over $3,000,000. But some other companies have expended large sums of money and realized little, and some nothing at all. We have no accurate figures for the earlier years; but, comparing the dividends with the assessments levied, we find that the aggregate produce of the mines has been swallowed up by expenses. In 1865, the dividends paid amount to $1,900,000, and the assessments levied to $1,950,000, or $50,000 more than the dividends.

In 1866, the dividends paid were $1,794,400; the assessments levied, $1,232,380. Dividends over assessments, $562,020. In the first years of operations on the Comstock Lode, the expenditures for machinery, which had to be transported from California across the Sierra Nevada Mountains, for the erection of costly reduction works, and for other permanent improvements, together with the extravagant prices paid for reducing ores in a very imperfect manner, absorbed nearly the whole produce. Latterly, the only increase of expense has been in mining operations; as greater depths were reached, a large amount of prospecting or dead work had to be done, and additions made to the pumping and hoisting machinery, almost counterbalancing the reduction in the cost of crushing the ore, of labor, and of freight, and we consequently find, that the aggregate profits of the mines at the end of the last year bear but a small ratio to the production.

The cost of labor and of reducing ores will gradually diminish from year to year, and on the completion of the Central Pacific Railroad from Sacramento to the valley of the Truckee river, which will certainly be effected in the year 1868, the price of transportation from San Francisco to the mines will not be more than one-third of the average rates heretofore paid. But we do not believe that any reduction of expenses on these items which can be made will be sufficient to meet the increased cost of working the mines after a few years, when greater depths are attained, if the present system of pumping out the water, and of raising the ore and refuse through shafts to the surface is continued.

STEAM ENGINES.

In the late report of R. H. Stretch, Esq., State Mineralogist of Nevada, we find it stated that forty-seven steam engines are now in oporation on the Comstock Lode, which answer all the present requirements; but every addition to

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the depth demands additional power, correspondent augmentation of capital invested in machinery, and a larger annual demand for fuel. The little wood there was originally in the vicinity of Virginia City was long since exhausted; it has now to be obtained almost exclusively from the eastern slope of the Sierra Nevada Mountains, and as the nearer timber is destroyed, it must be hauled a greater distance and at an increased price.

If we take into consideration the cost of machinery, of annual additions and repairs, and of consumption of fuel, wages of employés, delays caused by breaking of pumps, expense of explorations, obstacles in securing good ventilation and increase of heat with the depth, and the financial result of past years, *we are forced to the conclusion that the mode now adopted of working these mines cannot long be prosecuted with profit to the owners.*

The result of similar operations in other countries, as furnished by Humboldt, Ward, St. Clair Duport, and other writers, conveys an instructive lesson for persons interested in mining enterprises. These authorities agree, that mining from the surface must always prove suicidal to the interests of the owners when the position of the mines will allow the construction of adits or tunnels, which will drain the water, ventilate the mines, and diminish the cost of removing the ore and valueless material.

ALEXANDER VON HUMBOLDT.

Humboldt in his "Essay Politique sur la Nouvelle Espagne," published in 1811, in reference to the Veta Madre of Guanajuato, a lode much resembling the Comstock, exclaims:

"It is, indeed, strange that mines of such richness have no tunnels for draining when the neighboring ravines of Cata and Marfil, and the plains of Tumascatio, which are below the level of the lowest works of the Valenciana mine, would seem to invite the miner to commence works which would serve for drainage and at the same time afford facilities for transporting materials to the smelting and amalgamation works."

A gentleman of intelligence, whom Humboldt questioned in regard to this want of wisdom, replied, "that the excavation of a general tunnel would be a work very expensive, and perhaps impossible, on account of the *want of union among the proprietors of the different mines.*"

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THE VALENCIANA MINE.

Upon this lode is located the celebrated Valenciana mine, which, according to Humboldt, was first opened by Obregon, a young Spaniard, who, without means, commenced prospecting on a part of the vein which up to that time had been unproductive.

After undergoing many privations, he at last struck an immense body of ore, from which alone was extracted, from the first of January, 1787, to the 11th of June, 1791, the sum of $14,764,492 of silver, out of 134,988 tons of ore. Señor Obregon, afterwards known as the Count of Valenciana, became the richest man in Mexico, and probably in the world, at that time. As greater depths were attained, the increase of expense became such, that the mine ceased to yield a profit, and before the breaking out of the revolution in 1810, it was allowed to fill with earth and water. In 1825, this mine, together with many others, fell into the hands of a wealthy English company, who expended twenty-one months in draining it of water, but the expenses of mining and pumping were so great that after some years the lower works were again abandoned.

THE COUNT OF REGLA.

The most remarkable and disastrous experience made by any foreign company in Mexico, has been that of the English Real del Monte Company.

They became, in the year 1823, the possessors of the Biscanya and several other veins, the former having been worked for many years, and having yielded large amounts of silver, prior to 1749. At that date an intelligent miner, named Bustamente, concluded to run an adit, or tunnel, in order to effect their drainage. He labored long and patiently, and was supplied with means by Don Pedro Terreros, who continued the work after the decease of Bustamente. In 1759 the vein was reached, after running a tunnel 9,000 feet in length, cutting the vein at a depth of 600 feet beneath the surface, and exposing to view an immense body of ore. Terreros, in the twelve succeeding years, drew from his mines a clear profit of $6,000,000; he obtained the title of "Count of Regla" by the munificence of his donations to the Court of Madrid; he presented Charles III with two ships of the line, (one of 112 guns, constructed at Havana of the most costly materials,) and accommodated him besides with a loan of $1,000,000, no part of which has been repaid.

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His successor, the second Count, continued the working of the mines, but not with equal profit, for the upper portions of the vein being worked out, he was compelled to go below the adit, and the water encountered required 1,200 horses to pump it out, at an annual expense of $250,000. After struggling for many years, and after a depth of 324 feet under the adit had been reached, the work was abandoned, and the mine allowed to fill with water.

THE ENGLISH REAL DEL MONTE COMPANY.

It was in this state when the English Real del Monte Company took possession; they expected, by substituting powerful steam machinery for the horse whims, which had been employed by the Mexicans, to make the mines again profitable. The result, however, was very disastrous, for in the 23 years they held the mines the expenditures were $15,381,633; while the total yield was $10,481,475, showing a loss of nearly $5,000,000.

They first erected two steam engines of 36 inch cylinders each, which freed the mine from water to a depth of 324 feet under the adit; at this point another one was required and erected, of 54 inch cylinder, by which the working was carried to 724 feet under the adit; but here again the engines were overpowered, and still another engine of 75 inch cylinder was erected.

REPORT OF MR. BUCHAN.

Mr. John Buchan, the Superintendent of the mine, in one of his reports, made in 1852, says:

"After the mine had reached a depth of 710 feet under the adit, (1,310 feet below the surface,) the difficulties of drainage had so increased, both from augmented quantity of water and the greater height to raise it to the point of discharge, that three powerful steam engines could barely stem the coming waters of the mine.

"With the increased difficulty of drainage, seeing three bunches of ore worked out, and a debt of $5,000,000 still outstanding, it is not surprising that the energy and perseverance of the English adventurers were at last exhausted.

"Had the company prosecuted a projected deeper drain tunnel, it would have secured the continued prosperity of the mines for many years to come. It will be remembered that the first Count of Regla distinguished himself and made

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the fortune of his family, by driving the present adit; the second Count reached down 324 feet below it, being the limit to which the mines could be worked with profit by horse-power drainage. The English Company, by the powerful aid of steam machinery, carried down the workings to 720 feet below the adit; but here we find another limit to profitable working, as the deeper excavations of the Biscanya vein are again abandoned to fill with water.

"A deeper adit, which had to be driven a distance of 13,500 feet, had been commenced by the second Count. The English Company, unfortunately, adopted the more speedy plan, as it was supposed, of employing steam engines instead of the slower but surer plan of driving home the deep adit, which could have been done with the investment of but little more capital than that expended in applying steam engines, and would no doubt have given a very different turn to the fortunes of that company."

FINANCIAL HISTORY.

Mr. W. P. Robertson thus relates the financial history of this company:

"The London Real del Monte Company commenced working on a magnificent scale; then, under the influence of a panic, suddenly deserted, in the most critical time, their judicious and indefatigable agent at the mine, and the result has been unmitigated ruin. The mania in London at the time (1823 to 1825) was so strong and so general that no expenditure was for a moment grudged. People thought they were laying out tens to receive back thousands; so they paid up their tens with surprising alacrity. The management in London of many of the new companies under the reaction was miserably bad, and, in the end, many of the shareholders were completely ruined and retired to cottages, there to abandon forever their 'Chateaux en Espagne.'"

PRICE OF SHARES.

"In 1825, the late Mr. Kinder, the enthusiastic leader of the Real del Monte Company, was offered $8,000 for each of his thirty shares of $500 paid up in that concern; he refused to sell—that is, he would not take $240,000 for what had cost him $15,000. The reaction set in, and down went all shares. In 1845–46, those of Real del Monte were to be had at $12 50 each; that is, Mr. Kinder's thirty shares, which in 1825 were worth $240,000, had gradually dwindled

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down to $375! The company was all but bankrupt; no more assessments were listened to; and the debts could not be paid with unsaleable engines, though though they kept up their steam, nor yet with stones, although silver was in them. The shares have since gone to *nil*; no one will have them, fenced in as they are with unknown responsibilities and debts. In vain did their new, active, intelligent and enterprising, though prudent manager and agent, Mr. Buchan, write to the shareholders to take heart and not to throw away their property. They had been panic-stricken in the first instance, they had got sick of the business in the second, and in this last and most helpless fit, they entered into negotiations for the sale of the property to a Mexican Company. A bargain was struck, and the perpetual lease of Real del Monte, with everything on it, passed from the hands of the Real del Monte bond-holders for an old song. The entire sum paid was $130,000 for a business on which $7,000,000 had first and last been expended, and even of the mite to be recovered, three-fourths were not to go into the hands of the bond-holders at all, but were to be appropriated in Real del Monte itself, in the liquidation of sums still due to the servants of the old company. What a winding up! Shares once worth $8,000 each, now not worth thirty cents! and the actual movable property on the estate, in houses, workshops, machinery, crushing establishment, timber, wood, iron implements, utensils, steam engines, horses, horned cattle, mules, and many valuable miscellaneous materials, must be worth altogether some millions of dollars. The house of Regla alone cost a million and a half, and now is valued at a million of dollars—all gone for $130,000!

VALUABLE LESSON.

"Thus did Real del Monte pass from the Counts of Regla in Mexico, and thus has it passed from tne luckless shareholders in London—the first paying the penalty of personal extravagance, the other an equally severe one of wild speculation and injudicious management. It is now in wiser hands than theirs, and prosperity dawns again on this almost national establishment or colony."

This history of the Real del Monte mine teaches a valuable lesson, confirmed by the result of almost every similar enterprise in Mexico. They show that after a certain depth has been reached, and no drain tunnels constructed, the mines have been abandoned and the proprietors ruined.

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St. Clair Duport, who published a work on the mines of Mexico in 1843, gives a general sketch of mining operations, which is a perfect representation of recent experiences in California and Nevada. He says:

"OPENING A MINE.

"By accident, somebody discovers, guided by the croppings elevated above the soil, quartz containing some metal. He exposes some pieces to white heat, and if he discovers thereon globules, or pearls of silver, he takes up the claim. The discoverer now seeks partners with capital to work his claim, as generally the means of one man are not sufficient for such an enterprise. At first they generally seek to extract the ore by following down on the vein, and open a number of shafts along its course; but in the same ratio as these shafts increase in depth the water increases too; galleries and new shafts become necessary, and finally, as is generally the case when the largest portion of the yield has been expended in such operations, particularly in mines which are not extraordinarily rich in minerals, the work has to stop on account of bad air and abundance of water, the improvements being of no further use.

"The owners now look for new partners; if the vein presents probabilities of richness at a greater depth, persons can be found who, for a portion of the stock, generally for half, advance the necessary means which is to be repaid out of the first yield of the mine.

"LA BONANZA."

"After the water has been removed, and the shafts and galleries are made, and really rich ore is found, then commences the good time of the mine. Arrived at a depth where silver generally is abundant, and where the expenses to bring the water and ore to the surface are not too great, mining is a good paying business; that is what is called in the miner's language '*la bonanza.*' This time is hoped for with ardent desire, not only by the owners of the mine, and the miners employed, but also by the entire neighborhood. In this case labor, and all necessary articles for mining, are in demand, and well paid for; the money earned with ease is spent freely, and everybody in the whole mining region having any claims is full of hopes to strike it equally rich. The buildings for the reduction of ores are now erected, and very often in a style altogether too costly for their use. Next underground works are constructed to

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facilitate the hoisting of ore and water. In case the mines in '*bonanza*' belong to private individuals, these works are executed on a substantial basis, with a view of usefulness for the future. But in most cases, when a mine is divided amongst a number of shareholders, they present such a diversity of ideas, that they often cannot agree upon anything at all, except to extract the most money from their mine in the shortest time possible, without even looking ahead for a few months. For this reason we cannot find one single well-worked gallery in such mines. The richest ore is torn from the mine, and less rich ore remains untouched, to be taken out when '*la bonanza*' ceases. It is difficult to understand why in times of prosperity a small portion of the yield is not spent to make new developments.

ABANDONMENT OF THE MINE.

"The pay streak once traversed, and the increased depth rendering the price of extraction too considerable, the '*bonanza*' ceases. The less rich ore left in the mine is now taken out, and one of the greatest expenses being the keeping down of the water, the lower qualities of ore are abandoned.

"The reserved middle class of ores will pay expenses to explore the mine for awhile, but the time arrives when a day's work, or the value of a pound of ore, ceases to pay, and the mine is thereafter entirely abandoned."

The author of the above description of mining operations in Mexico, written twenty-five years ago, could not have given a more truthful account of operations on the Comstock Lode had he spent the last six or seven years in Virginia City. Our mining companies have been pursuing exactly the same course, and have followed in the foot-steps of their Mexican predecessors. Ruin of the owners and abandonment of the mines has been the result there; ruin and abandonment must follow upon the suicidal course pursued here.

MINING IN EUROPE.

If we turn to Europe, however, *we find that mining is carried on with intelligence, economy, and with a view to permanency.* In England but few mines are located at any considerable elevation above sea level, and deep drainage by adits is impossible. But each mine has its adit, however small its depth may be beneath the surface, and in stating the depth of shafts in England they are given from the adit downwards; what is above the adit is not counted at all.

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The most remarkable work of this kind in Great Britain is the great adit in Cornwall, of which an English writer says:

"The advantages of working mines by adits are well shown at the United mines, near Redruth, where an adit has been driven, commencing only a few feet above the sea level, which, with its branches, has a length of from thirty to forty miles, and a depth under the mines of from 180 to 420 feet. By means of this work a saving in the consumption of coal is effected amounting to 24,000 tons per annum. This magnificent undertaking was completed in 1768."

MINES IN GERMANY.

The mines in Germany present by far the finest field for studying mining operations, reduced to a science. There mining schools and learned professors have for years prepared young men, who were to be placed in charge of mines, with a thorough knowledge of all the varied branches required of mining engineers. It is owing quite as much to intelligent management as to the low rate of wages that mines are profitably worked in Germany; which would be considered valueless in California or Nevada. There we see the most complete systems of drainage and ventilation, and mines placed beyond the usual contingencies of such enterprises, yielding nearly uniform dividends, and regarded by capitalists as good security for investment.

THE FREIBERG DISTRICT.

Some years since it was proposed to drain the Freiberg mining district by an adit-level of the extraordinary length of twenty-four miles, which would cut the vein at a mean depth of 2,000 feet. This plan was vigorously supported by Von Beust and other eminent mining engineers, and received the sanction of the Saxon Government. This gigantic work has not yet been commenced, but a deep adit is now being driven, which will drain the mines 400 feet below the present deepest natural drainage, and will have a length of a little over eight miles. It is eight feet wide, nearly ten feet high, and rises in the whole distance twelve feet six inches.

In the Harz district some mines have attained an immense depth. The mine of Andreasberg has a depth of 2,450 feet, being one of the deepest mines in the world; adits have been run there for centuries, the largest of which was completed three years ago.

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THE ERNST AUGUST TUNNEL.

We make the following condensed extracts from a report made by Dr. Geissler, concerning this great work, called the Ernst August Tunnel, after the late King of Hanover:

"On the 22d of June, 1864, a drain tunnel was completed which may be called the greatest work of the kind ever executed. To explain its objects and importance it will be necessary to give the following details:

"The mines of the Harz were about to be abandoned, or, more properly speaking, about to be drowned out by water beyond redemption. In the course of time the explorations in those mines went deeper and deeper, until they reached a depth of 2,000 feet. While the higher situated galleries ceased to yield pay ore in sufficient quantity, the exceedingly rich ores discovered in the lowest levels could not be reached on account of great bodies of water, which pumps and engines could not master, and the lower levels had to be, for the time being, abandoned.

OLD TUNNELS.

"There have been drain tunnels in the Harz for a long time, which were used as canals for the transportation of ores. Already at the commencement of the sixteenth century mechanical means to remove the water from the mines were insufficient, and drain tunnels were constructed at that early period. The first tunnel was commenced in 1525, another in 1548, one in 1551, and still another in 1573. By aid of these tunnels mining was continued in those districts for 200 years, but about the middle of the last century it became difficult again to master the water.

"In 1799 another deep tunnel—having a length, including galleries, of 57,000 feet, or nearly eleven miles—was completed. But this also, afterwards, was considered insufficient for future purposes, for notwithstanding additional engines might have been used for a while, their dimensions and cost in mines which had reached such an enormous depth would have been very great. And, after all, the surest and cheapest way for water to be removed is by its natural flow; the engines have enough to do in pumping the water up to the Ernst August Tunnel, as that gives the deepest natural drainage which can ever be obtained.

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DESCRIPTION OF THE ERNST AUGUST TUNNEL.

"In 1850, after careful surveys and due consideration, the construction of the Ernst August Tunnel was resolved upon; it was to commence at Gittelde, a little town at the foot of the Harz mountains, and it was estimated that twenty-two years would be required for its completion, but it only took a little over half that time, for it was entirely completed in twelve years and eleven months. Nine shafts had been sunk, from which eighteen galleries or drifts were run, and one from the mouth, so that the work progressed from nineteen different points. The connections were made with such perfection that they could not be recognized after they were completed.

"This tunnel has a uniform fall of 5 4-10 inches to each 630 feet, or 1 in 1,400; its height is 8 feet 3 inches; its width, 5 feet 6 inches, and its shape that of an egg. The water has a sufficient depth to allow the use of long flat boats, for the transportation of ore. A part of the water course is covered over, to be used as a side walk for the miners."

NECESSITY OF A TUNNEL TO THE COMSTOCK LODE.

We have thus far reviewed the results of mining experience where drain tunnels have not been, and where they have been constructed, and the conclusion your committee arrives at is, *that a deep drain tunnel to the Comstock Lode will not only greatly facilitate mining operations, but it is an absolute necessity; the sooner it is constructed the more benefit will be derived therefrom, and without it nothing is more certain than the abandonment of those mines before the lapse of many years.*

The necessity of the tunnel having been sufficiently demonstrated, it remains to show that the ore which will probably be obtained from these mines will justify the cost of construction.

BARON RICHTHOFEN.

The first question to be examined is, whether the ore in the Comstock Lode extends to an unlimited depth. This question has been so ably handled by Baron Richthofen, an eminent geologist of the highest European reputation, that we content ourselves by giving some extracts from a letter written by him upon

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this subject, in February, 1865, and published in one of the pamphlets issued by the Sutro Tunnel Company. For a more detailed account of the geology of the Washoe country we refer to his able report, to be seen on the tables of this Institute.

CONTINUITY OF THE COMSTOCK LODE.

The learned Baron says: "The value of a deep tunnel will, of course, chiefly depend upon the question whether these mines will ever be worked to considerable depth; that is, whether the Comstock vein will extend far down, and whether it will retain its metalliferous character in depth. Both questions will have to be decided from the study of the structure and nature of the Comstock vein, and from comparing the results with the observations at such mines in other countries which have already been worked to great depth. My experience on the Comstock vein is based on close and repeated examinations of nearly all the mines on its course. I believe I concur with almost everybody who has had equal experience about them, in the opinion, that it is a true fissure vein, of extraordinary length, and extending downward much further than any mining works will ever be able to be carried on. It would be too lengthy to enumerate the various reasons which lead most positively to this conclusion. It is now assumed almost universally as a fact, and the number of those who consider it as a gash-vein, or a system of gash-veins, is fast diminishing.

"As to the downward continuance of the ore-bearing character, every instance goes to show that the average yield in precious metals remains about the same at every depth. Some mines had accumulations of ore near the surface, (Ophir, Mexican, Gold Hill;) in others, they commenced very near under the surface, (Gould & Curry, Potosi, Yellow Jacket, Belcher;) at others, again, considerable work had to be done before bodies of ore of any amount were struck, (Chollar, the southern part of Gold Hill, Uncle Sam, and others,) and some which had no ore heretofore, appear to have good prospects to find it soon. The fact that some rich bodies of ore, which were found near the surface, gave out at a depth of a few hundred feet, induced the common belief that the Comstock vein was becoming poorer in its lower parts. But the explorations of the last few months have entirely defeated this opinion. On the contrary, the enormous amount of bullion which is being produced by the mines at present may almost appear to prove that the vein is improving in depth. But this conclusion is probably

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equally fallacious, as it must be borne in mind that many mines have been developed at different levels, and ore is being extracted from several of those. Hoisting works and the mode of extracting the ore have also been improved, and of course help to increase the daily produce. This average equality of the produce of the vein at different levels is not only true for the amount of ore extracted, but also for its yield. The rich body of ore in the Ophir and Mexican mines forms the only exception to this rule, as none of equal average per centage in silver and gold has been found again. Even the relative proportion of gold and silver in the ore has not undergone any material change, though the bullion, on account of the more imperfect process of reduction, contained at first proportionately more gold than at present.

"There is no reason to doubt that the equality of the average produce and yield throughout the entire length of the vein will continue downward to any depth. Besides the very obvious theoretical conclusion, that vast amounts of silver could not be carried into the fissure from the overlying or enclosing rocks, but naturally had to rise from unknown depths, through the channel of the fissure itself, to be deposited in it where the conditions for sublimation or precipitation were given in its open space; experience in other countries by no means shows of a regular decrease or an increase in yield as of common occurrence, though either of them may happen. More commonly, the produce of true fissure veins in precious metals has been found to be about constant."

The Baron wrote the above over two years ago. The explorations made since that time in the Hale & Norcross and other mines, strongly confirm the views expressed by him.

OPINION OF OTHER WRITERS.

Nearly all writers who have specially studied the question of the continuance of mineral veins in depth, have arrived at the same conclusion. We will give an extract upon this subject from an eminent French writer, M. Burat. He says:

"In all countries where isolated veins are worked, a large number of them have been abandoned and taken up again; abandoned because accidents or barren streaks rendered the working burdensome; and afterwards taken up again, when they have, by the aid of capital, been made productive mines. The same veins have been declared to be rich or exhausted, for these reasons, at different times; exhausted always when the owners were discouraged, and rich after the

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execution of further works had pierced the barren places. These are the facts, of which we will relate several examples, and by which we intend to prove that each re-working of a vein after an abandonment more or less long, bears witness of the continuity of mineral veins in depth."

Burat and other prominent writers recite numerous instances of this kind, but we cannot give place to them in this report.

THE SUTRO TUNNEL.

The proposed tunnel begins 3½ miles below Dayton, between Corral and Webber Cañons. The distance from the mouth of the tunnel to the Savage works is a little over four miles, but as the Comstock Lode dips to the east, it will be cut in 20,178. It will pass through the different ledges in Silver Star and other districts nearly at right angles. Allowing a grade of *one* inch in 100 feet, or four and four-tenths feet per mile, it will be 1,922 feet below the floor of the Savage works. The topography of the country is admirably adapted for sinking shafts, four of which are proposed to be put down. They will not only supply the tunnel with fresh air, but will greatly expedite work, as drifts can be run each way after reaching the grade of the tunnel. The distance of the first shaft from the mouth of the tunnel is 4,070 feet—depth, 443 feet; second shaft from first, 5,150 feet—depth 980 feet; third shaft from second, 4,060 feet—depth, 1,436 feet; fourth shaft from third, 4,654 feet—depth, 1,360 feet; from fourth shaft to Comstock Lode 2,244 feet—depth, 1,922 feet. These are convenient distances for working and ventilation. The mouth is about one and a half miles from Carson river, and 150 feet above high water mark. There is a gradual descent for about one-third of a mile, in which a fall of 100 feet is obtained, giving sufficient area for dumping and mill-sites.

DESCRIPTION OF THE TUNNEL.

The vertical section of the tunnel through rock not requiring any support is a circle of twelve feet diameter, with offsets 3½ feet from the bottom, about one foot wide, which support the superstructure of the railroad track to be used for removing ore and *debris* from the mine. The space under the superstructure is for drawing the water from the lode. Where timber supports are required to sustain the adjacent rock, the top is level, and ten feet wide, clear of the framing; height, eight feet to the bottom of the timbers supporting the railroad,

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where it is twelve feet wide in the clear. Below this there is a triangular space, three feet seven inches in depth, forming the water way.

The estimates of the cost of construction have been very ably discussed in a lengthy report by R. G. Carlyle, Esq., covering some 200 pages of manuscript and illustrated by numerous well-executed diagrams. Mr. Carlyle has resided some years in Virginia City, when he was the Engineer of the Gould & Curry Company, and appears to be perfectly familiar with everything connected with mining in that country. The minuteness with which he goes into the details of the proposed work, the elaborate calculations into which he enters, and the scrupulous manner in which he weighs his conclusions, entitle his report to careful consideration.

CHARACTER OF ROCKS.

It is impossible for us to give more than a condensed abstract of the results he has obtained. The basis of his calculations is the experience of himself and others in mining near Virginia City, and the statements of Baron Richthofen in regard to the character of the material encountered in the construction of the tunnel. The Baron says:

"The facilities of excavating the tunnel would depend mainly upon the quality of the rock through which it will pass. It is a remarkably fortunate incidence that the route selected by Mr. Sutro not only gives the greatest depth, is the shortest, has the best facilities for working shafts, but promises also in this respect to be the most advantageous. The first 6,000 or 7,000 feet will be through trachyte and trachytic breccia, which, in a broad semicircular belt of prominent hills, swing from Dayton by the Sugarloaf to Washoe valley. Trachytic breccia may easily be worked by the pick, yet is ordinarily solid and dry enough to require no timbering. An idea of its excellent qualities for tunneling may be formed from the fact that in Hungary wine cellars hundreds of feet in length are with preference excavated in this kind of rock. The solid trachyte is an excellent blasting rock. Its superior qualities have caused its general use in Washoe for building material; it was as such applied in the construction of the solid masonry of the Gould and Curry mill. With the use of the drilling machine of Mont Cenis, speedy work will be made in this rock. The next 2,500 feet will, to all probability, exhibit a great variety of rock, some of which will be rather hard. The following 10,000 feet to the cutting of the vein will most likely consist of the same material as is traversed by the numerous

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tunnels which lead at present to the Comstock vein. This rock (trachytic greenstone) would offer some obstacles if it were in an undecomposed state. But from the general nature of its decomposition, which evidently was performed from below by ascending steam and vapors during a time of volcanic action, we believe we are justified in the conclusion, that it will be found for the entire length of 10,000 feet of the same rotten nature, as in the shallow tunnels at present in existence, and it may have to be timbered the whole distance."

TUNNELING IN NEVADA.

Mr. Carlyle speaks as follows in regard to his experience with the two principal kinds of rock to be encountered:

"While I was in the employ of the Gould and Curry as their Chief Engineer, we used solid trachyte for building purposes, taken from a quarry on the side of the Sugarloaf mountain. I had, therefore, considerable opportunity of learning the particular character of the stone. It is not porous, very close in its nature, has very few seams, no grains or special tendency to fracture in any particular direction. It is rather soft, and, in consequence, is easily drilled to any desired shape. The rock drills well and blasts freely, as it does not seem to have much cohesion on account of its many component parts. It does not air slack: on the contrary, it grows harder by exposure."

This rock is extensively used for building purposes; all the stone buildings in the town of Dayton are constructed of it.

His experience in working greenstone porphyry he gives as follows:

"This class of rock is traversed by several tunnels to the Comstock Lode, all of which were easily worked, and they had to be supported by timber. The Gould and Curry lower tunnel is the only exception to this, as it passed through 1,400 feet of undecomposed rock, which was not difficult to work on account of its favorable stratification; powder was used but to a small extent, and this for the purpose only of shaking the mass. The remaining 800 feet to the lode had to be timbered, as the rock would not support itself. The whole length of this tunnel, 2,200 feet, was run from one working point in 486 working days, or sixteen months; the work, however, was distributed over a period of two years, as it did not progress steadily. The average daily progress was nearly five feet."

Mr. Carlyle estimates that 10,535 lineal feet of tunnel will be through solid rock, and 9,643 through decomposed rock requiring timbering.

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Shaft No. 1 is 7½ feet by 13½ feet, and shafts Nos. 2, 3 and 4 are 7½ feet by 14 feet outside of planking. They are timbered and planked from top to bottom, and divided into two compartments—one for pumping out the water, and the other for raising the excavated material.

Preliminary tunnels are driven from the bottom of these shafts in both directions till they meet. These tunnels are in solid rock, 5 feet in width and 7 feet high, the top being a semicircle. In rock requiring timbering they are of a box shape, 4 feet wide on top, 5 feet on bottom, and 6 feet 4 inches inside of the timbering, with a channel below for drainage.

TIME REQUIRED TO FINISH TUNNEL.

"The time required to sink the different shafts on the Sutro Tunnel and make connections of the drifts from the same, I estimate as follows, on the basis that four feet can be sunk per day on the shafts, and five feet made on the drifts:

Connection from drift No. 1 in 462 working days.

Connection from drift No. 2 in 693 working days.

Connection from drift No. 3 in 708 working days.

Connection from drift No. 4 in 815 working days.

"Since all these shafts would be progressing at the same time, the connections from shafts Nos. 1, 2 and 3 will be made before those of No. 4, and the whole time, therefore, required to finish a preliminary tunnel to the Comstock Lode would be 815 days.

"The enlargement of this preliminary tunnel will progress from the mouth, from time to time, as the connections are made, and will be completed up to a point midway between shafts 3 and 4 by the time the last connection is finished. From that point 4,618 feet would still remain to be enlarged, which would occupy 116 days. The total time, therefore, required to complete the Sutro tunnel to the Comstock Lode would be 931 days, or 2 years 6 months and 21 days."

The Committee would remark in regard to the removal of the rock for 4,618 feet that, estimating the sectional area at 9 yards, the amount is only 13,854 cubic yards, on which, as the cut can be worked all along the top and at the two ends, a sufficient number of men can be employed to remove it in the time indicated.

Mr. Carlyle then cites numerous instances of shafts sunk by different companies, and tunnels driven to the Comstock Lode, which prove that his estimate of

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4 feet per day in sinking shafts and 5 feet in driving tunnels, whenever prosecuted with energy, is confirmed by experience, making due allowance for their size and other circumstances which in some cases have retarded work.

Your Committee are of the opinion that, with proper energy, a sufficiency of capital, and provided no extraordinary obstacles are encountered, the tunnel might be finished in the time stated, but it is so well known that delays are met with in works of this kind, from causes impossible to anticipate, that it is probable that an additional time of at least one year may be occupied. It is safe to say that, making all due allowance for contingencies, the tunnel can be completed in from three and a half to four years.

COST OF THE WORK.

The estimate of Mr. Carlyle is given very much in detail, and is accompanied by a number of bids from miners, foundry-men, boiler-makers and others, who state the prices at which they are willing to make the excavations, furnish the machinery and necessary mechanical works connected with the enterprise.

As the calculations of quantities are made with an unusual degree of care, there seems to be very little margin for variation from the estimate. We extract from Mr. Carlyle's report the following table of the cost of the work, which includes cost of tunnel, of a double track railroad and cars, stationary engines, ropes, and fixtures for the removal of the ore from the lode to the mouth of the tunnel:

SUMMARY OF ESTIMATE.

Materials and labor for sinking shafts and running preliminary tunnel, ...	$416,467 05
Materials and labor for enlargement of preliminary tunnel, ...	619,854 10
General materials and sundries not included above,	66,439 00
Machinery for the shafts, ...	121,679 00
Boilers for above machinery, . . .	33,736 40
Erection of machinery and necessary buildings, .	32,265 00
Expense of operating machinery in sinking shafts,	138,734 27
Expense of running preliminary tunnels, . .	324,784 90
Cost of best appliance, complete for hauling out ore, (3,000 tons per day,) . . .	49,328 00
	$1,803,287 72

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Add 10 per cent. for superintendence and general contingencies, ...	180,328 77
Grand total, . . .	$1,983,616 49

Cost per lineal foot, $98 25.

In the above estimate the cost of sinking an aggregate depth of 4,220 feet of shafts was,

For labor, excavating shafts and setting the timbers, (from proposal of Wm. Welch,) . . .	$117,270 00
Materials used, blacksmiths' and carpenters' work, .	70,158 16
Expense of engines and attendance, . . .	138,734 27
Total cost, ...	$326,162 43

Or $77 29 per foot lineal, exclusive of the cost of engines and machinery, which amounts to $187,680 40.

One of the engines is intended to be used after the completion of the tunnel to operate the machinery for moving the cars on the railroad. The remainder, and a portion of the machinery can be sold, but Mr. Carlyle has made no deduction from his estimates on account of proceeds obtained from their sale.

In the annual report of the State Mineralogist of the State of Nevada, for 1866, page 93, it is stated that the cost of sinking the shaft of the Gould and Curry Company, exclusive of cost of engines and machinery, was $75,378 40; depth attained, 692½ feet; price per foot, $109 36. The shaft consists of four compartments, five feet square, and is cribbed with twelve-inch timbers. It is capable of working the mine to the depth of 1,200 feet.

This shaft is about double the size of those proposed for the Sutro Tunnel, and the actual cost per foot lineal is but 41½ per cent. greater. It would seem, from this experience, that the estimate for the cost of the shafts is sufficient.

COST OF OTHER TUNNELS.

We do not find any statements of the actual cost of constructed tunnels of great length, and of as small dimensions as the one proposed by Mr. Sutro.

The Sapperton Tunnel, on the Thames and Severn Canal, England, through rock partly lined with masonry, is 12,900 in length; sectional dimensions, 15 by 15 feet, cost $12 44 per foot lineal.

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The Hare Castle Tunnel, on the Trent and Mersey Canal, England, through rock and sand, lined throughout with masonry, is 8,778 feet in length; sectional dimensions, 14 by 16 feet; cost $57 05 per foot lineal.

The Blissworth Tunnel, on the Grand Junction Canal, England, through rock and clay, lined throughout with masonry, is 9,240 feet in length; sectional dimensions, 16½ feet by 18 feet; cost $23 18½ per foot lineal.

Edge Hill Tunnel, on the Liverpool and Manchester Railroad, England, through clay and free-stone, partly lined with masonry, is 6,600 feet in length; sectional dimensions, 22 by 16 feet; cost, $30 15 per foot lineal.

It will be noticed that the sectional area of all these tunnels is about twice that of the one proposed by Mr. Sutro.

The Nochistongo Tunnel, made in 1607, to drain Lake Tumpango, in Mexico, is 21,659 feet in length through clay and marl; its dimensions are 13.78 by 11.48 feet, and it was completed in 287 days. The maximum depth below the surface was but 164 feet. Cost not stated.

REPORT OF GENERAL McCLELLAN.

We could, if our limits permitted, give statements in relation to many large tunnels constructed on lines of railroads, within a few years, but we will conclude our remarks on this subject by submitting an extract from Gen. McClellan's memoranda on railroads.

"The Nerthe Tunnel, near Marseilles, is 15,153 feet long; has twenty-four shafts, whose aggregate length is 7,589 feet, the deepest being 610 feet. It is in very hard limestone rock; is 29½ feet high by 26½ feet wide. The shafts are lined with masonry, a portion of the body of the tunnel is lined with masonry one, two and three bricks thick; another portion is not lined at all. A semi-circular brick aqueduct, 4½ feet in diameter, runs the whole length of the tunnel under the floor. The time occupied in the construction is not stated.

"The cost of the Nerthe Tunnel was as follows:

For mining the body of the tunnel,	$705,982 20
For mining the shafts,	109,081 08
Masonry for the shafts,	49,069 31
Lining for the body of the tunnel,	423,711 18
Cost of aqueduct,	10,607 10
Total cost of tunnel,	$1,298,450 87

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"The average cost of *excavating* the shafts, which are nine feet ten inches in clear diameter, was $43 per yard downward; the average cost of lining the shafts was $19 40 per yard down. The deepest shafts cost on the average, $73 per yard down, completed.

"Cost of mining the body of the tunnel, $139 76½ per running yard."

James Hayward, Civil Engineer, in his testimony before a Committee of the Legislature of Massachusetts on the Hoosac Tunnel, states that not more than five years were occupied in the construction of the Nerthe Tunnel.

The sectional area of this tunnel, supposing the top to be a semi-circle, as is usual on railroads, is about 700 feet, or more than six times that of the Sutro Tunnel.

These statements are given that those interested in such inquiries may institute a comparison between the cost of works which have been constructed with the one proposed by Mr. Sutro. In such a comparison due allowance must, of course, be made for the difference between the cost of labor and material in Nevada and in other countries.

After reviewing Mr. Carlyle's estimates as carefully as time would permit, we have come to the conclusion that liberal prices have been generally allowed for the several items of expenditure; but taking into consideration the liabilities of interruptions from breaking of machinery and irruptions of water, to which works of this description are subject, it would be safer to add for such contingencies 25 per cent. to his estimate, making the whole cost about $2,500,000.

PRIVILEGES GRANTED TO SUTRO TUNNEL COMPANY.

From a pamphlet published by Mr. Sutro in New York, in September last, we learn the following facts:

The Legislature of Nevada in February, 1865, granted to A. Sutro the exclusive right for fifty years to run a tunnel from the foot hills to the Comstock Lode, leaving the rates to be paid by the mining companies open to voluntary agreement. Subsequently a contract was made with all the leading companies, by which they agreed to pay two dollars for every ton of ore extracted after the main tunnel is completed and actually drain the mines; or, if they are not drained, then after a lateral drift reaches under any mine; one dollar per ton for every ton transported through the tunnel, and twenty-five cents for each man to be transported through the tunnel, either in or out.

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We understand from Mr. Sutro that these contracts are subject to the condition that he and his associates obtain subscriptions to the amount of $3,000,000 in currency prior to the 1st of August, 1868. The mining companies have already subscribed between $300,000 and $400,000, as part of the above amount, to become binding when the residue is subscribed.

In July, 1866, the Government of the United States passed a bill which grants—

1st. The right of way through the public domain for seven miles on or along the Comstock Lode, or any other lode which may be developed or discovered by the tunnel.

2d. The right to select one thousand two hundred and eighty acres of land at the mouth of the tunnel.

3d. The right or title to the mines for two thousand feet on each side of the tunnel, equal to five thousand and eighty acres of mining land.

4th. It makes all the mines of the Comstock Lode, or any other lode benefitted by the tunnel, tributary to the same, and compels the owners of all those mines to pay to the Tunnel Company the same rates of charges as agreed upon in the above mentioned contracts, and makes their title subject to that condition.

The aggregate income of the Tunnel Company from the various sources, taking the yield of the mines to be 1,500 tons daily, is $7,200 per day, or about $2,500,000 per annum; the yield of the mines, however, is expected to be largely increased after the completion of the tunnel, which would double or treble the income of the company.

A number of mines have been located east of the Comstock Lode, which show fair prospects on the surface and may be valuable in depth.

The land of the Tunnel Company will also prove of high value, for whenever the tunnel is completed a settlement will spring up at its mouth, as the mines must be entered and worked from that point.

FINANCIAL AID.

The evidence adduced by Mr. Sutro in the pamphlet referred to (copies of which are on the tables of the Institute) must be sufficient to satisfy any one who will take the pains to examine the subject, that the capital invested in the enterprise must yield a large revenue. When it is recollected, that the annual

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produce of these mines is about four-tenths of the whole yield of the precious metals in the States of Nevada and California, and that the prosperity of San Francisco is largely dependent upon the mineral resources of the country, we must conclude that every merchant, mechanic, manufacturer and landholder in this city is deeply interested in the project.

In this connection the Committee would call your attention to a letter to Mr. Sutro, dated October 5th, 1866, and signed by Moses Taylor, Peter Cooper, August Belmont, Eugene Kelly, R. C. Fergusson, Wm. T. Coleman, C. K. Garrison; Duncan, Sherman & Co., and other leading capitalists of New York. This letter is found in the pamphlet on the Sutro Tunnel, to which reference has been previously made:

"If the mining companies on the Comstock Lode, and the people of Nevada and California, who are familiar with the value of your mines, would evince their confidence in the enterprise by subscribing a portion of the requisite capital, say four or five hundred thousand dollars, and work on the tunnel is actually commenced, we think you will find it comparatively an easy task to obtain the balance of the funds here.

"We would consequently advise you not to lose any valuable time in futile attempts here or in Europe, where, no doubt, the same objections will be raised, but to return at once to San Francisco, and use your efforts there to get the work started."

That it is both the duty and the interest of the people of San Francisco to aid this enterprise, by such contributions as shall secure its success, is too evident to need further illustration or enforcement.

The Committee recommend the adoption of the following resolutions embodying a summary of the views expressed in the preceding report:

RESOLUTIONS.

First.—That the Comstock Lode is a vein of extraordinary value, presenting every feature of permanency and continuance in depth, much further than mining works can ever be carried.

Second.—That experience in all countries shows conclusively that the difficulties in drainage and ventilation limit the depth to which mines can be worked, and whenever attempts have been made to work them below this limit, without the aid of adits or tunnels, the result has been disastrous to the owners.

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Third.—That the proposed tunnel will, by affording good ventilation, diminish the temperature and greatly improve the sanitary condition of the miners.

Fourth.—That the Comstock Lode must have a drain tunnel, or the mines must be eventually abandoned.

Fifth.—That the proposed Sutro Tunnel is a work entirely feasible, and offers no unusual mechanical difficulties whatever, and we believe it can be constructed, with proper energy, judicious management, and a sufficiency of capital, in from three and a half to four years, at a cost of about $2,500,000. But were a work required of such magnitude as to cost $10,000,000, necessity would demand its construction.

Sixth.—That the rights granted to the Tunnel Company, the contracts made with the mining companies, and the chances of discovering valuable mines, make this enterprise one of the most promising undertakings ever projected on this coast, and offers extraordinary inducements for the investment of capital.

Seventh.—That by means of this tunnel a permanence and importance will be given to the mines on the Comstock Lode which can hardly be realized now; that the produce of bullion from the mines may be doubled, and even trebled, exercising a most beneficial influence upon the commerce, the industry and resources of San Francisco.

Eighth.—That every citizen of California and this coast at large, who has the future welfare of the Pacific States at heart, should lend a helping hand, and encourage, in every way and manner the execution of this great work.

Ninth.—That recognizing the influence which the production of the precious metals has upon the general welfare of the Nation, in increasing its taxable property, and consequently its revenue, we respectfully solicit Congress to give liberal aid to the work, in such manner as in their wisdom they may deem proper.

Tenth.—That we fully recognize the foresight of A. Sutro, Esq., in projecting this great work, and highly appreciate the intelligent manner in which he has presented to the public the importance and necessity of this enterprise.

All of which is respectfully submitted,

WM. J. LEWIS,
ARCH'D COOPER,
P. M. RANDALL.

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Act of the Legislature of Nevada;

CONTRACTS WITH THE MINING COMPANIES;

ACT OF CONGRESS,

AND ENDORSEMENTS.

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ACT

OF THE

LEGISLATURE OF THE STATE OF NEVADA.

AN ACT *granting the right of way and authorizing A. Sutro and his associates to construct a Mining and Draining Tunnel.* (*Approved April 4th*, 1865.)

The People of the State of Nevada, represented in Senate and Assembly, do enact as follows:

SECTION 1. A. Sutro and his associates, successors and assigns, shall, for the next fifty years ensuing, from and after the approval of this Act, have, possess and enjoy the exclusive privilege of the right of way, and to run, construct and excavate a tunnel, running into the Comstock Lode, from any point to be selected in the foot hills of the Carson river valley, within the boundaries of Lyon county, and between Coral Canon and Webber Canon; also, to sink mining shafts along the line or course of said tunnel, and connecting with the same at such points as may be selected by said parties; *provided, however*, the right of way hereby granted for said tunnel shall in no manner or in any wise interfere with any rights heretofore acquired in and to the said Comstock Lode, or any other lode along the line or in the vicinity of said tunnel, or any rights of property heretofore acquired by any person or corporation; and *provided, further*, that said right of way for said tunnel shall in no wise interfere with the rights of miners, according to the laws and customs of this State.

SEC. 2. That the object of said tunnel being for the purpose of draining the Comstock Lode, and all other lodes along its line of direction or course, and for the discovery and development of other lodes through which the same may pass, and for the general purpose of advancing the mining interest of this State, the the rate, price or sum of money to be charged for the benefit derived by the persons, companies or corporations along the line of said tunnel, and others who

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may be benefitted by the drainage of their mines or lodes, and freeing the same from the flow of water therein, shall be whatever sum or sums of money, or stock, which may or shall be agreed upon by and between the corporations, person or persons to be benefitted as aforesaid, and the grantee herein, his associates, successors or assigns. And the said A. Sutro and his associates, their successors and assigns, shall have the right to receive and collect all sums of money or stock which said persons, companies or corporations shall contract to pay; and in default of the payment of the same, according to the tenor and condition of such contract or contracts, the said A. Sutro and his associates, their successors or assigns, shall have the right, and are hereby authorized and empowered, to sue for and collect the same in any court of competent jurisdiction in this State.

SEC. 3. It shall be the duty of A. Sutro, his associates, their successors or assigns, to commence the work of said tunnel, in advancing the objects aforesaid, within one year from the passage of this Act, and to complete the same within eight years.

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United States
Revenue Stamp.

SEAL
of the Collector of
Internal Revenue,
California.

Revenue Stamp
of the
State of Nevada.

SEAL
of the Comptroller
of the
State of Nevada.

AGREEMENT.

THE SUTRO TUNNEL COMPANY WITH THE —— MINING COMPANY.

ARTICLES OF AGREEMENT, Made and entered into this ——— day of ——— A. D. one thousand eight hundred and sixty-six, by and between WILLIAM M. STEWART, D. E. AVERY, LOUIS JANIN, JR., H. K. MITCHELL, and A. SUTRO, Trustees for the SUTRO TUNNEL COMPANY, parties of the first part, and the ——— MINING COMPANY, a corporation doing business in the county of Storey, State of Nevada, party of the second part.

WHEREAS, by an Act of the LEGISLATURE OF THE STATE OF NEVADA, entitled, "*An Act granting the right of way, and authorizing A. Sutro and his associates to construct a Mining and Draining Tunnel,*" *approved February 4th,* 1865, the Legislature of said State granted to the said A. SUTRO and his associates, his and their successors and assigns, for the period of fifty years from and after the approval of said Act, the exclusive privilege of the right of way, and the exclusive privilege to run, construct and excavate a tunnel running into the Comstock Lode from any point in the foot-hills of the Carson river valley, within the boundaries of the county of Lyon, and between Webber Cañon and Corral Cañon; and also granted other rights and privileges, which fully appear in said Act:

AND WHEREAS, the said A. SUTRO, and the above-named WILLIAM M. STEWART, D. E. AVERY, LOUIS JANIN, JR., and HENRY K. MITCHELL, have associated themselves together, under the name and style of "THE SUTRO TUNNEL

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COMPANY" for the purpose of running and completing said tunnel in accordance with the terms and conditions of said legislative enactment:

AND WHEREAS, all corporations, associations, companies and individuals, owning or interested in the said Comstock Lode, are beneficially interested, by the drainage of their respective mines on the Comstock Lode, in the speedy completion of the said tunnel.

AND WHEREAS, the party of the second part is the owner of, in possession of, and working upon that certain portion of the said Comstock Lode in the county and State aforesaid, known as the ——— MINING COMPANY'S MINE; and as such owner is beneficially interested in the early completion of said tunnel, for the purposes of drainage aforesaid, and other conveniences thereby to be afforded: NOW, THEREFORE, these ARTICLES witness:

ARTICLE I. The parties of the first part, in consideration of the premises, and in consideration of the covenants and agreements hereinafter mentioned, to be kept and performed by the party of the second part, covenant and agree to and with the party of the second part, that the parties of the first part will, on or before the first day of August, 1867, commence and with reasonable energy and vigor, and at their own expense, run, excavate and complete the tunnel and lateral drifts hereinafter mentioned, and put the same in condition for use, in accordance with the provisions of the said Act of the Legislature of the State of Nevada, and with the covenants in this agreement contained, for the purpose of draining the mines on the said Comstock Lode and furnishing other conveniences for working the same.

ART. II. The said tunnel shall commence at some point in the foot hills of Carson valley, between Corral Cañon and Webber Cañon, within the county of Lyon, and shall extend to, and cut, and pass through, the said Comstock Lode to its western wall, at some point between the north line of the claim of the Ophir Silver Mining Company, and the south line of the claim of the Yellow Jacket Company, and at a depth of not less than one thousand eight hundred feet below the top of what is known as the Gould and Curry croppings.

ART. III. The parties of the first part covenant and agree that the work shall be commenced at the time specified, by running the tunnel from the foot hills of Carson valley; and also by simultaneously sinking at least three shafts of sufficient capacity on the line of the tunnel, and when the shafts have reached the depth required for the level of the tunnel, then to drift in both directions

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from the bottom of each shaft, so that there shall be at least seven places of excavation going on, from the time that all of the shafts shall reach the requisite level, all the time until the tunnel is completed, unless connections between some of the shafts are sooner made; and the said work at all times shall be prosecuted continuously and without any interruption, except from unavoidable accident, until the completion of the tunnel, and of the works which under this agreement are to be considered as draining the mine of the party of the second part; and in case of any such interruption occurring, the cause thereof shall be removed or remedied and the work resumed without delay.

And the parties of the first part covenant and agree, that on or before the said first day of August, 1867, there shall have been subscribed, in good faith and by apparently responsible persons, at least the sum of three millions of dollars for the purpose of carrying on and completing the said tunnel and the lateral drifts hereinafter mentioned; that of said sum at least ten per cent. shall have been actually paid in cash; that during the first year in which the work shall be prosecuted, commencing on said first day of August, 1867, there shall be expended upon, or on account of the work, not less than the sum of four hundred thousand dollars, and during each succeeding year thereafter, until the work shall be completed so as to drain the mine of the party of the second part within the meaning of this agreement, not less than the sum of two hundred thousand dollars; provided that this amount can be advantageously expended after the completion of the main tunnel, and that they, the parties of the first part, will, within thirty days after the expiration of each year, furnish to the party of the second part, a full, true and correct statement of the expenditures made on account of the work during such year, verified by the oath of the managing agent and secretary or book-keeper of the parties of the first part.

ART. IV. If the work shall not be commenced on or before the said day, and with said sum of three millions of dollars subscribed, and ten per cent. thereof actually paid in cash, as hereinbefore provided, or if, after so commencing, the parties of the first part shall during any year fail to expend on account of the work the sum of money hereinbefore agreed to be expended during such year, this agreement shall, at the option of the party of the second part, cease and determine, and thereafter be of no effect. And if, after the work shall have been commenced, it shall not be continuously prosecuted, as hereinbefore agreed, the party of the second part, in conjunction with other companies or corporations

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with which the parties of the first part may have entered into similar agreements, and which may desire to unite with the party of the second part in so doing, shall have the right to enter and take possession, and complete the work, or have it completed under contracts, at the expense of the parties of the first part, deducting the costs of its completion from the first moneys becoming due to the parties of the first part under this agreement.

ART. V. The parties of the first part further covenant and agree, that in the event they shall fail in obtaining subscriptions for the sum of three millions of dollars, or if the sum of three hundred thousand dollars shall not have been actually paid in cash, as hereinbefore agreed, on the said first day of August, 1867, then the said parties of the first part shall and will, if the party of the second part desire it, sell and convey within six months thereafter, the said franchise granted to A. SUTRO by said Act of the Legislature of the State of Nevada, of February 4th, 1865, and also three hundred and twenty acres of land at and including the mouth of said tunnel, to be selected by the purchasers, in one body and in a square or rectangular form, and if the latter, the length not to exceed twice the width, to the said parties of the second part, and to the other mining companies which have entered or shall enter into like contracts with the said parties of the first part, and shall join in the purchase, for the sum or price of one hundred thousand dollars, each company paying thereof its *pro rata*, according to the number of feet of ground owned by each.

ART. VI. The dimensions of said tunnel shall be not less than seven feet in height in the clear, and eight feet in the clear in width. It shall have a grade of not less than one inch to the one hundred feet, and on the floor two substantial railways shall be laid down for the running of cars to and from the mine, and sufficient for the transportation of all materials to be used in said mine, and to convey all ore, debris, earth and rock from the mine to the mouth of the tunnel. And the said tunnel shall also have capacity to carry all water running into it from any source, and to discharge the same at the mouth thereof.

ART. VII. If the said main tunnel shall intersect the said Comstock Lode outside of the northern and southern boundaries of the mine of the party of the second part, the parties of the first part shall excavate or run a lateral drift, either within said Comstock Lode, or at any point not exceeding five hundred feet from and east of the west wall thereof, to a point from which a drift at right angles from said lateral drift will cut the said Comstock Lode

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between the north and south boundaries of the claim of the party of the second part; such lateral drift shall be of sufficient height and width to allow the free flow of all water coming into the same, also for the laying down of a double railroad track, and for the transportation of timber and other materials to said mine, and the conveying of ores, earth, rock and debris therefrom, and such railways shall be laid down by the parties of the first part the entire length of such lateral drift, and the grade thereof shall be the same as in the main tunnel.

ART. VIII. After the completion of the tunnel and such lateral drifts as may be necessary to comply with the preceding Articles, the party of the second part shall have the privilege to enter into said tunnel and the lateral drift, and to work through the same, having ingress thereto and egress therefrom, and to excavate and run any drift or drifts necessary to cut said Comstock Lode within the boundaries of the claim of said party of the second part, and to connect such lateral drift with the mine and mining works of said party of the second part, in such manner and by means of such drifts or other works as the party of the second part may think proper for the purpose of draining and conveniently working its mine.

ART. IX. The parties of the first part, from and after the completion of said tunnel—if the same intersects said lode within the northern and southern lines of the said second party's claim—or if not, then from and after the time when the parties of the first part shall have extended their lateral drift to a point opposite the claim of the party of the second part, and from which the party of the second part shall desire to make any connection between said lateral drift and its own works, shall convey, by means of said tunnel, drifts and railways, from the mouth of the tunnel to the point at which the drifts or works of the party of the second part connect with the drift or tunnel of the parties of the first part, all trustees, officers, agents and employees, who may desire to go into said mine, and shall also by the same means convey them from the same point to the mouth of the tunnel, such conveyance to be made whenever the same is desired by the party of the second part, and in as expeditious a manner as the nature of the case will allow, and without any unreasonable delay.

And the parties of the first part shall, after the time in this Article mentioned, also convey to the same point from the mouth of the tunnel, all timber, material, tools, machinery and implements for mining, which the party of the second part may desire to use in its said mine, and shall also from said point of connec-

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tion, convey to any point designated by the party of the second part, outside of the tunnel, and not more than one thousand feet from the mouth of the tunnel, all ore, rock, earth and debris, which said party of the second part may desire to remove from its said mine or works.

ART. X. The parties of the first part shall keep the said tunnel, and their own lateral drifts and railways and machinery for transportation as aforesaid, in good condition, so as not to interrupt or delay the party of the second part in the transportation of its officers, agents and employees, or the materials as aforesaid, to and from said second party's mine, and shall also keep said tunnel open for the free flow of all waters coming into it, or into said drifts, for the full drainage of said mine; and in the event that any accident should occur, or the works aforesaid should in any manner be rendered unfit for said purposes, the same shall be remedied with all reasonable dispatch, and without unnecessary delay. And should there be any obstructions to the flow of water through said tunnel or lateral drift, so as to retard the drainage of the said second party's mine, such obstructions shall be removed as soon as possible, according to the circumstances; and if the parties of the first part shall fail, within a reasonable time, to remove such obstructions or to put said tunnel and their own lateral drifts, railways, or machinery, in good condition, the party of the second part shall have the right to enter and remove such obstructions, or make any needful repairs, at the expense of the parties of the first part.

ART. XI. The parties of the first part further agree, that the prosecution of said work shall be as diligent and vigorous as the circumstances and the nature of the work will allow, and that the completion thereof shall not be unreasonably delayed.

ART. XII. In consideration of the foregoing covenants and agreements to be kept and performed by the parties of the first part, and for valuable considerations from the parties of the first part moving, to the party of the second part, the said second party covenants and agrees to pay to the parties of the first part two dollars per ton for all ore extracted from the mine of said second party, after the works of said first parties shall have drained the said second party's mine, so as to render all other means of drainage unnecessary to the lowest level attained; provided such level is not lower than the level of the tunnel herein provided for. Also, during the time when said party of the second part shall use said tunnel or drifts as means of transportation as hereinbefore contracted for,

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the party of the second part will pay to the parties of the first part for each ton of ore, rock, earth or debris removed from the point hereinbefore designated, to or beyond the mouth of the tunnel, as the case may be, the sum of twenty-five cents per mile from the place of removing it, to the place of discharging it, and at the same rate for all material conveyed from the mouth of the tunnel to said point of connection heretofore described, forty cubic feet of timber, or twenty-two hundred and forty pounds of rock, ore or other material being considered a ton, and will also pay the said parties of the first part the sum of twenty-five cents each way for each man conveyed to and from the said point, at the request of, or on account of the said second party; all laborers, employees, agents and other persons connected with the said corporation of the second part, to be included and paid for as above stated. And if at any time the mining works of the party of the second part shall reach a level lower than the level of the tunnel aforesaid, the party of the second part shall be permitted, by means of pumps, or otherwise, to raise water from such lower level to the level of said tunnel or lateral drift, and the water so raised shall be discharged by means of the tunnel, as if the same were struck on or above such level. *Provided*, that the party of the second part shall only pay to the parties of the first part the said sum of two dollars per ton on the ore extracted which said second party shall have reduced at some mill or other reduction works, or shall have sold; *and provided further*, that no such payment shall be due or made, until the works of the parties of the first part shall have either actually drained said mine, so as to obviate the necessity for all other modes of drainage, or shall be prosecuted to the extent in the next article mentioned, which shall be deemed and considered sufficient drainage within the meaning of this agreement; *and provided further*, that said sum of two dollars per ton shall only be due and payable during such time or times as the said works shall actually drain said mine as aforesaid, or shall be in good condition to the extent in the next article mentioned; and no sum of money shall be due or payable to the parties of the first part, on account of ores extracted, during any time or times when the said second party's mine is not drained, by reason of any obstruction or defect in the tunnel or drifts of the said first parties.

ART. XIII. It is mutually agreed, that the true intent and meaning of these articles, as to the draining of the mine of the party of the second part, are, that whenever the said mine is actually drained by the works of the said first parties,

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so as to render all other means of drainage useless, to the lowest level attained by the works of the said party of the second part, but not lower than to the level of the tunnel, the same shall be deemed a full compliance with the covenant of the parties of the first part for the drainage thereof, and whether said mine be actually so drained or not, it shall be deemed and considered drained within the meaning of this agreement, in either of the following events:

If the main tunnel shall intersect the Comstock Lode, and cut the eastern wall thereof, between the north and south boundaries of the mine of the said second party, the mine shall be considered drained.

Or it shall be considered drained, if the main tunnel shall cut said eastern wall outside of those lines, and the parties of the first part shall extend the lateral drift hereinbefore covenanted to be extended within said Comstock vein, to a point equidistant from such north and south boundaries.

Or it shall be considered drained, upon the expiration of three months after the parties of the first part shall have extended said drift outside of said lode, but within five hundred feet east of the west wall thereof, to a point not more than five hundred feet east of said west wall, whence a drift at right angles would enter said lode at a point equidistant from the northern and southern boundaries of the claim of the second party.

ART. XIV. The party of the second part, after the completion of the works aforesaid according to the meaning and intent of the preceding article, agrees and binds itself to furnish to the parties of the first part, on the fifth day of each and every month, (unless that day be Sunday, and in that event on the sixth day,) a full, fair and just account of each ton of ore extracted from its mine, and reduced at some mill or other reduction works, or sold for such reduction, during the month preceding, or which may have been sent by the party of the second part to such mill or other reduction works to be reduced; and on the day of rendering such account, or within three days thereafter, shall pay to the parties of the first part the said sum of two dollars for each ton of ore so extracted, and on the same day shall pay such other sum as may be due for the transportation or conveyance of the workmen, or other persons, and of ores, rock, debris, timber, and other material, to or from said mine; *Provided*, that if, during the month preceding, the mine of the party of the second part shall not have been drained, by reason of any defect or obstruction in the works of said parties of the first part, the said sum of two dollars per ton on account of

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ores so extracted during the time such obstruction existed, shall not be due or payable, but only the sums due for other causes shall be due and payable at such time.

ART. XV. If any question should arise between the parties to this agreement, either in respect to the time when the mine of the party of the second part shall have been drained in accordance with the foregoing articles, and the payment of two dollars per ton for ore extracted should commence, or in respect to the amount of money at any time due or payable from the party of the second part to the parties of the first part, it is agreed that such question shall be determined by each party choosing one competent and disinterested person as an arbitrator; and in the event of disagreement between such arbitrators, they shall choose a third competent and disinterested person; the arbitrators shall be sworn, and a majority of the three may decide the disagreement between the parties hereto, and their decision shall be final. For the purpose of deciding such issue, the arbitrators, in the presence of each party, or upon reasonable notice thereof in writing, may receive evidence of witnesses, or other proofs; and either party, in the presence of the other, or upon reasonable notice in writing, may produce evidence before the arbitrators so chosen. The decision of the arbitrators shall in every case be made in writing, and it shall be binding and effectual from the time that a copy thereof, certified by the arbitrators, or a majority of them, shall have been delivered to both parties.

ART. XVI. If the parties of the first part shall, at any time, enter into any agreement with any other person, company or corporation holding a mine upon the Comstock Lode, in respect to drainage, transportation, or other advantage derived from the works of the parties of the first part, upon terms more favorable to such person, company or corporation than those herein contained, the party of the second part shall be entitled, at its option, to all the benefits thereof, as fully and to the same extent as if they were herein set forth and made part of this agreement.

ART. XVII. Each and every of the articles of this agreement shall be binding and of full force against each party hereto, and upon the assigns and successors thereof; and said assigns or successors shall be entitled to all the benefits and privileges thereof, as if the same were in each article distinctly set forth. And it is agreed, that if the said coporation, party of the second part, should in any manner be dissolved, or if it should convey the said mine, the grantees and suc-

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cessors of said corporation shall take the said mine subject to the conditions and obligations of this agreement, which it is agreed shall constitute and be a lien in law and equity on said mine, for the faithful carrying out of the covenants herein contained.

ART. XVIII. It is agreed that all payments provided in this agreement to be made by the party of the second part to the parties of the first part, shall be made in gold coin, and not otherwise.

IN TESTIMONY WHEREOF, the said parties hereto set their names and affix their seals, the day and year first above written; the name of the party of the second part being hereto subscribed, and its corporate seal affixed, by ———, President, and ——— Secretary, duly authorized by a Resolution of the Board of Trustees of said party; these presents being executed in triplicate.

WM. M. STEWART, [SEAL.]
ADOLPH SUTRO, [SEAL.]
LOUIS JANIN, JR., [SEAL.]
HENRY K. MITCHELL, [SEAL.]
D. E. AVERY, [SEAL.]

STATE OF NEW YORK,
CITY AND COUNTY OF NEW YORK, } ss.

On this eighth day of August, A. D. one thousand eight hundred and sixty-six, before me, C. von Hesse, a Commissioner of Nevada, duly commissioned and sworn, residing in the city of New York, personally appeared the above named Wm. M. Stewart, whose name is subscribed to the foregoing instrument as a party thereto, personally known to me to be the individual described in and who executed the said foregoing instrument, and acknowledged to me that he executed the same freely and voluntarily, and for the uses and purposes therein mentioned.

NOTARIAL SEAL.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year in this Certificate first above written.

CHRISTIAN VON HESSE,
Commissioner for Nevada.

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STATE OF NEVADA, }
COUNTY OF STOREY, } ss.

On this twenty-eighth day of April, A. D. one thousand eight hundred and sixty-six, before me, H. M. Morgan, Notary Public in and for said county, duly commissioned and sworn, and residing in the city of Virginia, personally appeared the above named Adolph Sutro, Henry K. Mitchell, Lewis Janin, Jr., and D. E. Avery, whose names are subscribed to the foregoing instrument as parties thereto, personally known to me to be the individuals described in and who executed the said foregoing instrument, and acknowledged to me that they executed the same freely and voluntarily, and for the uses and purposes therein mentioned.

NOTARIAL SEAL.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year in this Certificate first above written.

H. MORGAN,
Notary Public.

SAVAGE MINING COMPANY.

Corporate Seal of the Savage Mining Co.

By { ALPHEUS BULL, PRESIDENT.
{ E. B. HOLMES, SECRETARY.

STATE OF CALIFORNIA, }
CITY AND COUNTY OF SAN FRANCISCO, } ss.

On this third day of April, A. D. 1866, before me, Otis V. Sawyer, a Commissioner of Deeds, for the State of Nevada, duly commissioned and sworn, residing in said city and county of San Francisco, personally appeared the above named Alpheus Bull, President, and E. B. Holmes, Secretary of the Savage Mining Company, whose names are subscribed to the foregoing instrument, personally known to me to be the individuals described in and who executed the said instrument, who acknowledged to me that on behalf of the said Savage Mining Company they executed the same freely and voluntarily, and for the uses and purposes therein mentioned.

NOTARIAL SEAL.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal, the day and year in this Certificate first above written.

OTIS V. SAWYER,
A Commissioner of Deeds for the State of Nevada.

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CALIFORNIA SILVER MINING COMPANY.

Corporate Seal of the California Silver Mining Company.

By { WM. E. BARRON, PRESIDENT,
GEORGE STAACKE, SECRETARY.

Acknowledged, San Francisco, April 20th, 1866, before HENRY HAIGHT, Commissioner of Deeds for Nevada.

YELLOW JACKET SILVER MINING COMPANY.

Corporate Seal of the Yellow Jacket Silver Mining Co.

By { JOHN B. WINTERS, PRESIDENT,
WM. H. WATSON, SECRETARY.

Acknowledged, Gold Hill, Nevada, April 25th, 1866, before WM. E. HALE, Notary Public.

THE GOULD & CURRY SILVER MINING COMPANY.

Corporate Seal of the Gould & Curry Silver Mining Co.

By { ALPHEUS BULL, PRESIDENT,
J. M. SHOTWELL, SECRETARY.

Acknowledged, San Francisco, March 29th, 1866, before OTIS V. SAWYER, Commissioner of Deeds for the State of Nevada.

CENTRAL SILVER MINING COMPANY.

Corporate Seal of the Central Silver Mining Co.

By { B. F. SHERWOOD, PRESIDENT,
J. S. BURGESS, SECRETARY.

Acknowledged, San Francisco, May 9th, 1866, before HENRY HAIGHT, Commissioner of Deeds for Nevada.

BELCHER COMPANY.

Corporate Seal of the Belcher Company.

By { F. A. TRITLE, PRESIDENT,
H. BRUCKMANN, SECRETARY.

Acknowledged, Virginia City, Nev., April 27th, 1866, before H. M. MORGAN, Notary Public.

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CROWN POINT GOLD AND SILVER MINING COMPANY.

Corporate Seal of the Crown Point Gold & Silver Mining Co.

By { A. H. BARKER, PRESIDENT,
J. H. JONES, SECRETARY.

Acknowledged, San Francisco, April 12th, 1866, before HENRY HAIGHT, Commissioner for the State of Nevada.

CONFIDENCE SILVER MINING COMPANY.

Corporate Seal of the Confidence Silver Mining Co.

By { GEO. W. STEWART, PRESIDENT,
R. WEGENER, SECRETARY.

Acknowledged, San Francisco, April 6th, 1866, before GEORGE T. KNOX, Commissioner for Nevada.

CHOLLAR-POTOSI MINING COMPANY.

Corporate Seal of the Chollar-Potosi Mining Co.

By { A. K. P. HARMON, PRESIDENT,
W. E. DEAN, SECRETARY.

Acknowledged, San Francisco, April 20th, 1866, before E. P. PECKHAM, Commissioner for Nevada.

ALPHA GOLD HILL MINING COMPANY.

Corporate Seal of the Alpha Gold Hill Mining Co.

By { THOMAS SUNDERLAND, PRESIDENT, *pro tem.*
THEO. A. HALE, SECRETARY.

Acknowledged, Gold Hill, Nev., April 25th 1866, before WM. E. HALE, Notary Public.

HALE & NORCROSS SILVER MINING COMPANY.

SEAL.

By { GEO. S. MANN, PRESIDENT,
JOEL F. LIGHTNER, SECRETARY.

Acknowledged, San Francisco, April 11th, 1866, before HENRY HAIGHT, Commissioner for Nevada.

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BACON MILL AND MINING COMPANY.

Corporate Seal of the Bacon Mill and Mining Co.

By { C. L. LOW, PRESIDENT,
W. E. DEAN, SECRETARY.

Acknowledged, San Francisco, April 19th, 1866, before HENRY HAIGHT, Commissioner for Nevada.

GOLD HILL QUARTZ MILL AND MINING COMPANY.

Corporate Seal of the Gold Hill Quartz Mill and Mining Co.

By { OTTAVIANO GORI, PRESIDENT,
WM. V. GARVEY, SECRETARY.

Acknowledged, San Francisco, April 19th, 1866, before HENRY HAIGHT, Commissioner for Nevada.

IMPEPIAL SILVER MINING COMPANY.

Corporate Seal of the Imperial Silver Mining Co.

By { G. F. LAWTON, PRESIDENT,
DAVID A. JENNINGS, SECRETARY.

Acknowledged, San Francisco, April 17th, 1866, before HENRY HAIGHT, Commissioner for Nevada.

EMPIRE MILL AND MINING COMPANY.

Corporate Seal of the Empire Mill and Mining Co.

By { SQUIRE P. DEWEY, PRESIDENT,
GEO. R. SPINNEY, SECRETARY.

Acknowledged, San Francisco, April 14th, 1866, before F. J. THIBAULT, Commissioner for Nevada.

BEST & BELCHER MINING COMPANY.

Corporate Seal of the Best & Belcher Mining Co.

By { WM. M. LENT, PRESIDENT,
WM. WILLIS, SECRETARY.

Acknowledged, San Francisco, April 20th, 1866, before HENRY HAIGHT, Commissioner for Nevada.

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OPHIR SILVER MINING COMPANY.

Corporate Seal of the Ophir Silver Mining Co.

By { WM. BLANDING, PRESIDENT,
THOS. J. LAMB, SECRETARY.

Acknowledged, San Francisco, April 16th, 1866, before HENRY HAIGHT, Commissioner for Nevada.

OVERMAN SILVER MINING COMPANY.

Corporate Seal of the Overman Silver Mining Co.

By { JAS. J. ROBBINS, PRESIDENT,
GOMER EVANS, SECRETARY.

Acknowledged, San Francisco, April 19th, 1866, before HENRY HAIGHT, Commissioner for Nevada.

WHITE & MURPHY GOLD AND SILVER MINING COMPANY.

Corporate Seal of the White & Murphy Gold & Silver Mining Co.

By { D. N. WALTER, PRESIDENT,
JAS. P. NOURSE, SECRETARY.

Acknowledged, San Francisco, April 12th, 1866, before F. J. THIBAULT, Commissioner for Nevada.

[SEAL.] GUIDO KÜSTEL,
[SEAL.] CH. V. BESELER,
[SEAL.] MIRANDA BESELER.

Acknowledged, San Francisco, April 21st, 1866, before HENRY HAIGHT, Commissioner for Nevada.

[SEAL.] A. HIRSCHMAN,
[SEAL.] LOUIS GERSTLE.

Acknowledged, San Francisco, May 2d, 1866, before HENRY HAIGHT, Commissioner for Nevada.

[SEAL.] THOMAS B. HOWARD,
[SEAL.] MARY B. HOWARD.

Acknowledged, San Francisco, April 25th, 1866, before HENRY HAIGHT, Commissioner for Nevada.

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EXTENSION OF TIME.

This Agreement made this ——— day of April, 1867, between the ——— Mining Company, a corporation duly organized under the laws of the State of California, and having its mine on the Comstock Lode, in the State of Nevada, party of the first part, and the Sutro Tunnel Company party of the second part,

Witnesseth, That in consideration of one dollar in gold coin of the United States, in hand paid to the said party of the first part, by the said party of the second part, and of other good and valuable considerations, receipt whereof is hereby acknowledged, said party of the first part agrees and covenants that said party of the second part shall have and is hereby granted an extension of time for one year from and after the period specified in Articles First, Third, Fourth and Fifth, of a certain contract entered into between the parties hereto on the ——— day of ——— 1866, and it is hereby declared to be the intention of said grant of extension of time, that the operation and effect thereof shall be the same in all respects as if the first day of August, 1868, had been originally inserted in said contract, instead of the first day of August, 1867, wherever the date last mentioned is found therein.

In testimony whereof, the ——— Mining Company has caused these presents to be signed by its President and Secretary, and its corporate seal to be affixed this ——— day of April, 1867.

[*Here follow signatures of the Presidents and Secretaries of the Mining Companies with their corporate seals.*]

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ACT OF CONGRESS,

APPROVED JULY. 25, 1866.

AN ACT *granting to A. Sutro the right of way, and granting other privileges, to aid in the construction of a Draining and Exploring Tunnel to the Comstock Lode, in the State of Nevada.*

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That for the purpose of the construction of a deep draining and exploring tunnel to and beyond the Comstock Lode, so-called, in the State of Nevada, the right of way is hereby granted to A. Sutro, his heirs and assigns, to run, construct, and excavate a mining, draining, and exploring tunnel; also to sink mining, working, or air shafts along the line or course of said tunnel, and connecting with the same at any points which may hereafter be selected by the grantee herein, his heirs or assigns.

The said tunnel shall be at least eight feet high and eight feet wide, and shall commence at some point to be selected by the grantee herein, his heirs or assigns, at the hills near Carson river, and within the boundaries of Lyon county, and extending from said initial point in a westerly direction, seven miles, more or less, to and beyond said Comstock Lode; and the said right of way shall extend northerly and southerly on the course of said lode, either within the same, or east or west of the same; and also on or along any other lode which may be discovered or developed by the said tunnel.

SEC. 2. *And be it further enacted*, That the right is hereby granted to the said A. Sutro, his heirs and assigns, to purchase at one dollar and twenty-five cents per acre, a sufficient amount of public land near the mouth of said tunnel for the use of the same, not exceeding two sections, and such land shall not be mineral land or in the bona fide possession of other persons who claim under any law of Congress at the time of the passage of this Act; that upon filing a plot of said land the Secretary of the Interior shall withdraw the same from sale, aud upon payment for the same a patent shall issue.

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And the said A. Sutro, his heirs and assigns, are hereby granted the right to purchase, at five dollars per acre, such mineral veins and lodes within two thousand feet on each side of said tunnel as shall be cut, discovered, or developed by running and constructing the same, through its entire extent, with all the dips, spurs, and angles of such lodes, subject, however, to the provisions of this Act and to such legislation as Congress may hereafter provide: *Provided*, That the Comstock Lode with its dips, spurs, and angles, is excepted from this grant, and all other lodes with their dips, spurs, and angles, located within the said two thousand feet, and which are, or may be at the passage of this Act, in the actual bona fide possession of other persons, are hereby excepted from such grant.

And the lodes herein excepted, other than the Comstock Lode, shall be withheld from sale by the United States; and if such lodes shall be abandoned or not worked, possessed and held in conformity to existing mining rules, or such regulations as have been or may be prescribed by the legislature of Nevada, they shall become subject to such right of purchase by the grantee herein, his heirs or assigns.

SEC. 3. *And be it further enacted*, That all persons, companies or corporations, owning claims or mines on said Comstock Lode or any other lode, drained, benefited or developed by said tunnel, shall hold their claims subject to the condition (which shall be expressed in any grant they may hereaftor obtain from the United States) that they shall contribute and pay to the owners of said tunnel the same rate of charges for drainage or other benefits derived from said tunnel or its branches, as have been or may hereafter be named in agreements between such owners and the companies representing a majority of the estimated value of said Comstock Lode at the time of the passage of this Act.

UNITED STATES OF AMERICA,
DEPARTMENT OF STATE.

To all to whom these presents shall come, greeting:

I certify, that the document hereunto annexed, is a true copy of the original on file in this Department.

IN TESTIMONY WHEREOF, I, WILLIAM H. SEWARD, Secretary of State of the United States, have hereunto subscribed my name and caused the seal of the Department of State to be affixed.

SEAL of the Department of State.

Done at the City of Washington this thirtieth day of July, A. D. 1866, and of the Independence of the United States of America the ninety-first.

WILLIAM H. SEWARD.

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INSTRUCTIONS FROM THE GENERAL LAND OFFICE.

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE, *August* 1, 1866.

REGISTER AND RECEIVER, CARSON CITY, NEVADA,

Gentlemen:

I enclose herewith a preliminary survey of a drainage and exploring tunnel to the Comstock Lode, authorized to be constructed by A. Sutro, as per Act of Congress approved July 25, 1866, granting to said Sutro, for the purpose aforesaid, the right of way to run, construct and excavate a mining, draining and exploring tunnel; also to sink mining, working or air shafts along the line or course of said tunnel and connecting the same at any points, which may hereafter be selected by the grantee herein, his heirs and assigns.

The Act aforesaid also grants to said Sutro, his heirs and assigns the right to purchase, at $1 25 per acre, a sufficient amount of public lands near the mouth of said tunnel for the use of the same, not exceeding two sections, which shall not be mineral lands or in the bona fide possession of other persons, who claim under any law of Congress at the time of the passage of the Act aforesaid. Said Act further grants the right to purchase at $5 per acre such mineral veins or lodes within two thousand feet on each side of said tunnel as shall be cut, discovered or developed by running and constructing the same, through its entire extent, subject to the provisions of this Act, and to such legislation as Congress may hereafter provide.

The Comstock Lode and such other lodes as may be in possession of other persons at the passage of the Act are excepted from the grant.

You will see from the enclosed diagram that said tunnel runs through the public lands, from a line dividing sections 1 and 2 in Township 16 N. of Range 21 E. to section 23, in Township 17 N. of Range 20 E.

Lands indicated by yellow shading at the mouth of the tunnel, on the accompanying map, (green on the map attached to this book) are the particular tracts selected by said Sutro, under the said act, and claimed by him to be necessary

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for the use of the same, and those shaded blue (red on the map attached to this book) are the particular tracts which said Sutro claims the right to purchase along the line of said tunnel.

The tracts above designated, as aforesaid, will be withheld from market until it shall be ascertained whether any of said tracts fall within any one of the exceptions named in said Act, and until said Sutro shall have had a reasonable time to comply on his part with the conditions of the law, and to show by satisfactory proof before purchase as to the actual amount of land needed at the mouth of said tunnel, for the use of the same, not to exceed two sections.

You will, therefore, upon the receipt of these instructions, withdraw from sale, location, pre-emption or homestead claims the lands along the line, and at the mouth of said tunnel, indicated by said coloring.

Acknowledge the receipt of this letter.

Very respectfuly, your obedient servant,

J. M. EDMUNDS,
Commissioner.

Approved August 1, 1866.

JAS. HARLAN,
Secretary Interior.

I, J M. EDMUNDS, Commissioner of the General Land Office, do hereby certify that the foregoing copy of a letter of the present date from this office to the Register and Receiver of the Land Office, at Carson City, Nevada, is a true and literal exemplification of the original, as of record in this office.

SEAL
of the United States
General Land Office.

In testimony whereof, I have hereunto subscribed my name and caused the seal of this office to be affixed at the City of Washington, on the day and year above written.

J. M. EDMUNDS,
Commissioner of the General Land Office.

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ENDORSEMENT BY BANKERS OF SAN FRANCISCO, CAL.

Fully appreciating the benefits which would accrue to the people at large of the Pacific States, by securing the permanent working of the Comstock Ledge, which in our opinion would be accomplished by constructing a deep drain tunnel, we most cheerfully endorse Mr. Sutro's proposition to the Companies, *and shall do all in our power to assist him in carrying out his project.*

JOHN PARROTT,
LOUIS McLANE,
W. C. RALSTON.

SAN FRANCISCO, *March* 1, 1865.

OPINION OF MINING SUPERINTENDENTS—AND OTHERS.

The undersigned, fully aware of the importance and urgent necessity of providing means for draining the Comstock Ledge by means of a deep drain tunnel, and foreseeing the difficulties which must present themselves, before long, in removing the water from these mines; and being satisfied that the best interests, of not only the owners of the Comstock Ledge, but the people at large of this State, would be seriously effected by neglecting this matter: we would most earnestly recommend the immediate construction of such a work, and ask the co-operation of all parties interested, in order that this important undertaking may be speedily carried out.

VIRGINIA, *February* 15*th*, 1855.

WM. SHARON, Agent of Bank of California.
CHAS. BONNER, Superintendent Gould & Curry S. M. Company.
JOHN B. WINTERS, President Yellow Jacket S. M. Company.
F. A. TRITLE, President Belcher M. Company.
A. E. DAVIS, General Superintendent Ophir S. M. Company.
HARVEY BECKWITH, Superintendent Mexican Mine.

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O. H. Frank, Superintendent Central S. M. Company.
Pat. N. McKay, Superintendent California S. M. Company.
James Morgan, President Sides Company.
H. H. O'Reiley, Superintendent White & Murphy Company.
Thos. G. Taylor, Superintendent Best & Belcher M. Company.
Sam'l F. Curtis, Superintendent Savage M. Company.
Chas. L. Peck, Superintendent Hale & Norcross S. M. Company.
I. Adams, Superintendent Chollar S. M. Company.
Pat. N. McKay, Superintendent Potosi G. & S. M. Company.
J. M. Walker, Superintendent Bullion M. Company.
P. S. Buckminster, Superintendent Imperial S. M. Company.
John H. Mills, President of Superior Company.
Robert Apple, Superintendent Minerva Consolidated M. Company.
R. Graves, Superintendent Empire M. & M. Company.
W. Tozer, President Challenge S. M. Company.
L. U. Colbath, Superintendent Challenge S. M. Company.
L. S. Bowers, owner in Gold Hill.
Lindauer & Hirschman, owners in Gold Hill.
Chas. Pioda, owner in Gold Hill.
J. Woodruff, Superintendent Bacon M. & M. Company.
Wm. Arrington, President Confidence Company.
Robert Apple, President Apple M. & M. Company.
Winters, Kustel & Co.. owners in Gold Hill.
M. A. French, owner in Gold Hill.
H. Woodcock, Superintendent Crown Point Company.
Wm. Arrington, President Overman Company.
C. C. Thomas, Superintendent Uncle Sam Company.
Paxton & Thornburg, Bankers.
Jas. H. Latham, Agent Wells, Fargo & Co.
B. F. Hastings & Co., Bankers.
E. Ruhling & Co., Bankers.
Almarin B. Paul & Co., Bankers.
Maynard & Flood, Bankers.
M. C. Hillyer, Trustee Chollar S. M. Company.
A. Meyer, Trustee Hale & Norcross S. M. Company.
D. E. Avery, General Agent New York & Washoe M. Company.

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J. R. WILLIAMS, Superintendent Sierra Nevada S. M. Company.
W. E. BIDLEMAN, Superintendent Utah Company.
J. NEELY JOHNSON. owner in Virginia City Mines.
H. F. RICE, Agent Wells, Fargo & Co's, Carson.
F. RICHTHOFEN.
JOHN CRADLEBAUGH.
GILLIG, MOTT & Co.
W. M. BROWN, Mining Engineer.
C. V. BESELER, Mining Engineer.
JOHN A. VEATCH, Mining Engineer.
JOHN WHITE, formerly of the United Mines, Cornwall,
S. M. JOHNS, formerly of the Wheal Prosper Mine, Cornwall.
J. F. LEWIS, Chief Justice Supreme Court.
C. M. BROSNAN, Justice of Supreme Court.
W. O. BEATTY, Justice of Supreme Court.
RICHARD RISING, District Judge, Storey County.
R. S. MESICK, District Judge, Storey County.
C. BURBANK, District Judge, Storey County.
J. L. CROSSMAN, Lieutenant Governor.
C. W. NOTEWARE, Secretary of State.
H. W. NIGHTINGILL, Controller of State.
E. RHOADES, State Treasurer.
N. W. WINTON, State Senator.
M. S. THOMPSON, State Senator.
J. SEELY, State Senator.
A. J. LOCKWOOD, State Senator.

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RECOMMENDATION TO THE MINING COMPANIES TO ENTER INTO A CONTRACT WITH THE SUTRO TUNNEL CO.

THE UNDERSIGNED, *Presidents, Trustees and Stockholders of Mining Companies on the Comstock Ledge*, hereby recommend the speedy adoption of the contract offered to them by the Sutro Tunnel Company, which contract, in our opinion, presents the best plan for accomplishing the great and absolutely necessary labor of draining the lode to a great depth, besides furnishing the best means of ventilation, and the cheapest mode of extracting the ore.

SAN FRANCISCO, *October* 27, 1865.

CHARLES BONNER, Trustee Savage S. M. Company.
B. F. SHERWOOD, Trustee Gould & Curry S. M. Company.
JOHN B. WINTERS, President Yellow Jacket Company.
WM. BLANDING, President Ophir Silver Mining Company.
EDWARD MARTIN, Trustee Ophir Silver Mining Company.
WM. B. JOHNSTON, Trustee Ophir Silver Mining Company.
JOS. C. VANDERVOORT, Trustee Ophir Silver Mining Company.
A. L. DAVIS, Trustee Ophir Silver Mining Company.
JAS. MORGAN, President Sides Company.
JOHN RICKELTON, Superintendent Sides Company.
D. N. WALTER, President White & Murphy Company.
L. GERSTLE, Trustee White & Murphy Company.
P. ROUSSET, Trustee White & Murphy Company.
A. L. GREELEY, Trustee White & Murphy Company.
A. WASSERMAN, Trustee Best & Belcher Company.
HENRY VOORMAN, Trustee Best & Belcher Company.
H. M. NEWHALL, Trustee Best & Belcher Company.
H. WOODLEAF, Trustee Best & Belcher Company.
ALPHEUS BULL, President Gould & Curry S. M. Company.
D. B. WILLIAMS, Trustee Gould & Curry S. M. Company.
A. L. TUBBS, Trustee Gould & Curry S. M. Company.
R. B. WOODWARD, Trustee Gould & Curry S. M. Company.
JOHN O. EARL, Trustee Gould & Curry S. M. Company.

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LOUIS JANIN, Superintendent Gould & Curry S. M. Company.
J. M. SHOTWELL, Secretary Gould & Curry S. M. Company.
ALPHEUS BULL, Trustee Savage S. M. Company.
ISAAC GLAZIER, Trustee Savage S. M. Company.
SAMUEL F. CURTIS, Superintendent Savage S. M. Company.
GEORGE S. MANN, President Hale & Norcross Company.
M. MORGENTHAU, Trustee Hale & Norcross Company.
N. VAN BERGEN, Trustee Hale & Norcross Company.
STEPHEN MOORE, Superintendent Hale & Norcross Company.
JOEL F. LIGHTNER, Secretary Hale & Norcross Company.
A K. P. HARMON, President Chollar Potosi Company.
M. C. HILLYER, Trustee Chollar Potosi Company.
W. E. BARRON, Trustee Chollar Potosi Company.
LLOYD TEVIS, Trustee Chollar Potosi Company.
CHARLES HOSMER, Trustee Chollar Potosi Company.
CHARLES BONNER, President Bullion Company.
W. T. O'NEALE, Trustee Bullion Company.
J W MACKEY, Trustee Bullion Company.
THOS. H. WILLIAMS, Trustee Bullion Company.
J. W. WALKER, Superintendent Bullion Company.
G. W. HOPKINS, Secretary Bullion Company.
O. A. SANBORN, Trustee Alpha Company.
J. W. CARRICK, Trustee Alpha Company.
J. C. COREY, Trustee and Superintendent Alpha Company.
L. W. COE, President Imperial Company.
G. T. LAWTON, Trustee Imperial Company.
CHARLES HOSMER, Trustee Imperial Company.
J. B. DICKINSON, Trustee Imperial Company.
A. H. BARKER, Trustee Imperial Company.
J. E. DE LA MONTAGNIE, Trustee Imperial Company.
P. S. BUCKMINSTER, Superintendent Imperial Company.
CHARLES BONNER, President Bacon Company.
L. GERSTLE, Trustee Bacon Company.
J. GREENEBAUM, Trustee Bacon Company.
J. B. LOW, Superintendent Bacon Company.

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O. H. GIFFIN, President Empire Company
S. P. DEWEY, Trustee Empire Company.
ROBERT SHERWOOD, Trustee Empire Company.
CHARLES MAYNE, Trustee Empire Company.
W. T. GRISSIM, Eclipse Company.
W. K. ROGERS, Eclipse Company.
LOUIS SLOSS, Eclipse Company.
CHARLES FORMAN, Superintendent Eclipse Company.
JOHN MCDONALD, Jr., President Confidence Company.
O. A. SANBORN, Trustee Confidence Company.
J. GREENEBAUM, Trustee Confidence Company.
JOS. TODMAN, Trustee Confidence Company.
W. H. FORBES, Trustee N. Y. & Nevada and N. Y. & Washoe Cos.
D. E. AVERY, Gen. Sup't N. Y. & Nevada and N. Y. & Washoe Cos.
JOHN GILLIG, Trustee Yellow Jacket Company.
N. A. H. BALL, Trustee Yellow Jacket Company.
CHARLES FORMAN, Trustee Yellow Jacket Company.
A. H. BARKER, President Crown Point Company.
ISAAC GLAZIER, Trustee Crown Point Company.
GEO. T. GRIMES, Trustee Crown Point Company.
M. MORGENTHAU, Trustee Crown Point Company.
J. H. JONES, Secretary Crown Point Company.
F. A. TRITLE, President Belcher Company.
J. W. WOODRUFF, Trustee Belcher Company.
GEO. F. JONES, Trustee Belcher Company.
H. BRUCKMAN, Secretary Belcher Company.
JAS. J. ROBBINS, President Overman & Uncle Sam Company.
W. W. STOW, Trustee Overman & Uncle Sam Company.
RICHARD NEWBY, Trustee Overman & Uncle Sam Company.
J. M. MCPHERSON, Trustee Overman & Uncle Sam Company.
CHARLES C. THOMAS, Sup't Overman & Uncle Sam Company.
ROBERT APPLE, Segregated Belcher Company.
W. E. BIDLEMAN, President Utah Company.
PIERRE VENARD, Gold Hill M. & M. Company.
G. KUSTEL, Consolidated M. Company.

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MEMORIAL

OF THE MINERS AND RESIDENTS OF THE PACIFIC COAST FOR THE AID OF GOVERNMENT IN THE CONSTRUCTION OF THE SUTRO TUNNEL.

To the Honorable the Senate and House of Representatives of the United States of America:

Your Memorialists, miners and residents of the Pacific States, most respectfully show:

That the western regions of the United States embrace, by estimation, one million square miles of mineral land, containing gold and silver mines of untold wealth.

That the principal and permanent deposits of gold and silver are found in the quartz lodes of the country, the main wealth of which is encountered at great distances from the surface.

That quartz mining at great depth, in most cases, cannot be made profitable, except by means of extensive works, such as drain tunnels, requiring the outlay of large amounts of money.

That private capital is reluctantly invested in such enterprises; for, although the continuity and the metalliferous character of mineral lodes in depth are clearly proven by theory and by experience in other countries, it has never yet been practically demonstrated in this country.

That one *great index work* is required to establish that proof practically, which will give a stimulus and confidence, heretofore unknown, to private enterprise in similar undertakings.

That if Government will lend its aid to one grand work of this kind, no further aid will be asked or required by the miners of this coast.

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That the Comstock Lode is, by far, the most important mineral vein at present worked in the world, producing $16,000,000 per annum.

That it is most favorably situated on the side of a high mountain, which declines into a valley from which a horizontal adit or tunnel, four miles in length, can be constructed, by which the mines can be worked to a depth of 3,000 feet beneath the surface.

That, by common consent, this tunnel is looked upon by the miners of the Pacific coast, as the great test work for the entire mining region, which is to prove the continuance of mineral lodes in depth.

That the magnitude of the proposed work, and the results to flow from its completion, as favorably affecting great financial questions, justly assign to it a National ground.

Therefore, Your Memorialists would respectfully pray that such government aid be extended to the "Sutro Tunnel Company," as may insure the speedy completion of the work.

[Here follow many thousand Signatures.]

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Miscellaneous Extracts

AND

NEWSPAPER ARTICLES.

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EXTRACTS.

Extracts from the opinion of Alexander Von Humboldt, on the construction of a deep tunnel in the Freiberg district.

I have been honored with the request, to give a professional opinion about the means which will secure the welfare of the mines in the Freiberg district for centuries to come; mines which have been a highly productive source of the national wealth of Saxony, and believe best to comply with the same, by compiling in a few pages the facts, which induce me, after the most mature and impartial deliberation, to concur fully with the report of the mining department.

As a pupil of Werners, and educated as a practical miner at the Academy of Freiberg, I have deeply felt the duty to earnestly consult the experiences, which I have gathered in an active life, (sometimes superintending mining operations, although in a limited circle; sometimes professionally studying the extraction of ore in the American Cordilleras and the Russian portion of Northern Asia,) in order not to recommend an undertaking inconsiderately, which will withdraw important sums from other portions of the Government's resources, but which will establish new and lasting sources of prosperity.

The principal points, which are to be considered here, are threefold. Is there no other remedy, shorter and cheaper, than the Meissen Tunnel, to save the mines of Freiberg? Is it probable, that the ores will continue at such great depth? Is it not to be considered that unexpected accidents in such a length of time may occur to interfere with the undertaking? These three questions, I hope, will be satisfactorily explained in the following remarks, based upon the materials collected with so much foresight by the Royal administration.

Not trusting entirely to my own views, I have in this important examination and in making this report consulted a good friend (the Royal Prussian Chief Mining Counsellor von Dechen*) who not only may be counted amongst the most illustrious geologists of Germany, but who by his travels in the most important parts of Europe and by his own professional calling, is intimately acquainted with practical mining and smelting operations.

Von Humboldt enters at length into the discussion of these questions, answers them most conclusively, and earnestly recommends the construction of the proposed tunnel.

Extract from a Review of the Mineral Land Act, by Gregory Yale. Published in the Pacific Law Magazine, April Number, 1867.

The Sutro Tunnel Act is a partial legislation by Congress to regulate important mining interests, and as such the proper subject of comment in this connection.

On the 25th of July, 1866, one day prior to the general act, an act was passed granting the right of way, and other privileges to Adolph Sutro, and his assigns, to aid in the construction of a draining and exploring tunnel to the Comstock Lode, in the State of Nevada to sink mining, working, or air shafts along the line or course of the tunnel, and connecting with the lode at any point to be selected by the grantee. The tunnel is to be at least eight feet high and eight feet wide, and to commence at a point at the hills near Carson river, to be selected, extending to a point in a westerly direction seven miles, more or less, to and beyond the lode. The right of way is also granted on or along any other lode which may be discovered or developed by the tunnel. The act authorizes the purchase of not

* A letter from Dr. H. von Dechen will be found on page 38 of this book.

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more than two sections of public land at the mouth of the tunnel, for the use of the same, not being mineral land, or in the *bona fide* possession of any person under any law of Congress, at the date of the act, at the minimum price, and the right to purchase, at $5 00 per acre, such mineral veins or lodes within two thousand feet on each side of said tunnel as shall be cut, discovered, or developed by running or constructing the same, through its entire extent, with the dips, spurs and angles of such lodes, subject to the provisions of the act, and the future legislation of Congress. The Comstock Lode, and all other lodes, located within the two thousand feet, in the actual possession of other persons, are excepted from the grant. All of these lodes, excepting the Comstock, are withheld from sale by the act, unless abandoned, or not worked in conformity to existing mining rules, or such regulations as have been or may be prescribed by the Legislature of Nevada; in that event these other lodes are subject to the right of purchase by the grantee. By the 3d and last section of the act, all persons and companies owning claims or mines on the Comstock, or any other lode, drained, benefitted, or developed by the tunnel, shall hold their claims subject to the condition, to be expressed in any grant from the United States, that they will contribute and pay to the owners of the tunnel the same rate of charges for drainage or other benefits derived from the tunnel or its *branches*, as have been, or may be, named in (any) agreement between such owners and the companies representing a majority of the estimated value of said Comstock Lode at the date of the act. (14 Stat. at Large, 242–3.)

This is the first act of Congress granting a mining privilege on public land to any individual, or to the public at large. It was evidently intended to be cotemporaneous with the general law under consideration; but it was necessary, for the security of the exclusive privileges granted, that it should be prior in date. In principle, the law assumes the function of regulation, or the administration of the mines, in an important argentiferous locality, by recognizing the necessity of drainage, and the equitable adjustment of payment therefor, and for other advantages, according to the benefits derived by proprietors of the lodes cut by the tunnel. It might as well have provided for the payment at once, as the power existed, as to leave it the subject of agreement by a majority in value; or of a forced payment by all, in proportion to benefits, instead of a forced payment, by the minority in value. The minority now pays by compulsion from the majority, instead of being compelled to pay directly by the act. There is no doubt that the lodes benefitted are, by this law, subjected to a lien to the extent of the agreements, by their respective owners; and the claims of the minority owners are in the like condition by the force of contracts not of their making. The existing mining rules, and the regulations prescribed by the Legislature of Nevada, are also distinctly recognized.

The principle of *pro rata* payments by the parties benefitted, to the constructors of a general tunnel, is a fixed regulation in the mining codes. They are always constructed under the authority of the officers appointed to direct the proper working of the mines. In the Spanish system a tunnel is called a *contramina*, or *socabon*, which is rendered in English by the mining term adit, corresponding to the American term tunnel, in the sense used in the Sutro Act. The royal ordinances promulgated in May, 1783, of New Spain, title X, contain seventeen articles, relative to this and kindred subjects, in great detail, and almost completing a system. By article 2d, it is ordered that all veins requiring draining, and whose situation will admit of it, and when, in the judgment of the professor of the district, advantage will result from it, the owners shall be obliged to make an adit sufficient for clearing the workings. Article 3d contains the principle of the Sutro Act. When several mines can be cleared and kept in order, and each, singly, cannot bear the expense of the construction of an adit, *it shall be made and paid for by all together*, the expense being apportioned among them, according to the benefit each shall derive from it, when ascertained, it being arranged according to what the poorest mine can pay as the work progresses, so as not to suspend the work, and all shall be assessed, and regulated by the mining deputation and its respective professor. An individual, not being an owner, may denounce several mines for the purpose of constructing a tunnel, in case the owners refuse, the work to be planned and directed by the professor of the district, never to exceed two varas, or six feet in width, and nine feet in height. If the adventurer, in the progress of the work, discovers new veins, he will be rewarded as such, under the ordinances; and if already known, then one *pertenencia* in each vein. Abandoned mines through which the tunnel passes may be denounced as in this act they may be acquired by its terms, together with half of the metals he takes out of occupied mines. But in case of such denouncement, the constructor pays all the expenses. One or more owners of a mine, may, in like manner, construct a general countermine alone, or in partnership with an adventurer, subject to the same provisions. When mines which require draining do not admit of countermining, by means of an adit from their situation, a general or continuous shaft, called a *tiro*, to draw off the water by means of engines

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or machines, may be constructed upon the same general principles, under the authority and direction of the proper officer. (*Halleck's Collection Mining Ordinances*, 246-51.) The old mining ordinances of Spain, prior to the compilation of the New Code of 1584, and subsequently inserted in the law of the Indies, and made applicable to New Spain, in force till 1783, provided for contraminas. Laws 79, 80, 81, 82 of these ordinances, relate to the subject, and will be found, with comments thereon, in chapter 26 of Gamboa, 2d vol., 295. They are similar in principle to Law X of 1783. But it is remarkable, that the four laws of 1584, had none corresponding to them in the older ordinances, as Gamboa tells us. (2 vol., 299.)

In the French mining code the tunnel is called *areine*, and corresponds to the Spanish *contramina*. The law of 1810, art. 45, and other articles, regulate their construction, but in less detail, and with less reference to relative responsibility, than the Spanish code. (*De Fooz* by *Halleck*, 148.) By an ancient custom of Liege, an assessment, as perpetual as the benefit, called the *cens d'areine*, was imposed upon the owners of mines benefited by a general canal, and, like the *droit de tirage*, was a real or immovable right. *Id.* chap. i, § 3.

By the Gold Field Management Acts of New South Wales, 16 Vict., No. 43, (1852,) the commissioner having the authority in any district may permit persons, by written license, without a fee, to employ themselves in cutting or making tunnels, for the purpose of directing water courses, or carrying away superfluous water from auriferous lands.

There is no provision in these acts for payment by those whose lands are benefited by the drainage in the latter case, and is left by implication to rest upon private agreement.

It is not difficult to extract from the common law, a principle sufficiently broad to compel *pro rata* payments by the owners of mining claims benefited by a general enterprise, having for its object a system of drainage and working common to a number of mines, so situated as to receive the benefit, in the nature of a lien upon the mines or their products. There are analogous rules, applied to real property, which could be extended without much violation, so as to embrace the principle, upon the well known rule, that the common law expands and adapts itself to new conditions of society and property, for protection and security, and, in some cases anticipating legislation. There is no doubt that where parties avail themselves of the advantages of the work, an implied obligation would result, to be enforced as a contract.

In the absence of legislation to regulate the working of the mines in our State, there is no statutory obligation, in the nature of a contract *in invitum*, which the law makes for a party, as in the Sutro Tunnel Act, where a majority of value which agrees to pay binds the minority which refuses, like the system of grading and sewerage in cities.

Extract from the Report of Surveyor General of Nevada, Hon. S. H. Marlette, Esq., for 1865.

GREAT SUTRO DRAIN TUNNEL.

Some facts concerning this grand enterprise will be found in the report of the County Surveyor of Lyon County. That its construction is an absolute necessity, must be considered by all who believe that we have not already obtained the cream of the Comstock Lode. The tunnel projected by A. Sutro, Esq., is intended to drain the Comstock 2,000 feet below the Gould & Curry croppings, nearly 1,200 feet lower than the Gold Hill and Virginia tunnel, and the same distance below the present bottom of the Bonner shaft; more than 1,550 feet lower than the Latrobe Tunnel, and about 550 feet below the surface of Washoe Lake, and nearly 1,200 feet below the present workings in the Gold Hill claims. * * * * * * *

The quantity of water that is now pumped up from the mines cannot be ascertained; no record is kept; nearly every mine of note has its pump, which usually stands idle part of the day; in the deep and more extensive works, the pumps work night and day. The Best & Belcher and Hale & Norcross, each, during portions of last summer, pumped 15,000 gallons of water per hour. The Gould & Curry pump has a capacity of 25,000 gallons per hour.

"For a long time, the works of the Ophir and Mexican mines were flooded in spite of all the efforts of powerful pumps. Such has been the case with other mines. It has been estimated, and I think without extravagance,

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that at 1,800 feet the quantity of water in the Comstock Lode will be 480,000 gallons per hour, and the cost of pumping it up would be at least $4,000,000, of which expense about one-fifth would be the interest on cost of machinery." * * * * * * * * * * * *

VENTILATION.

Good ventilation is very important. In illy ventilated mines, the workmen are sickly; the heat, foul air, and mud interfere with their work, and the moisture causes the wood to rot with fearful rapidity. I have been frequently in mines surveying, when the air was so bad that it would take days to recover from the ill effects of inhaling the foul atmosphere but for a few hours perhaps. What then must be the effects resulting from weeks, months, and even years, of breathing such pestilential vapors. Surely, such trifling with human life should be avoided.

In 1864, nearly 16,000,000 feet (board measure) of timber, at a cost of nearly $640,000 was used for the Comstock mines, and there are now probably 50,000,000 feet (board measure) within the same. It has been said that more has been used in the Gould & Curry mine than in building Virginia City.

Whether this 50,000,000 feet of lumber, with the 15,000,000 to be added annually, is to last eight or ten years, or rot in three or four, depends on good or bad ventilation, and with this tunnel it could be far better than without. It has been estimated that four-fifths who die in mines are victims of bad air.

From the Report of John Day, County Surveyor of Lyon County, to the Surveyor General of Nevada, for 1865.

The greatest and most important enterprise to the county (and State) is "Sutro's Deep Drain Tunnel" to the Comstock. The starting place of the tunnel is about three and a half miles northerly from Dayton, between Corral and Webber Cañons. The distance from mouth of tunnel to the Savage works is a trifle over four miles, but as the Comstock dips to the east, it will probably be cut in three miles and a half. * * *

It is of public importance; it is, in fact, a mining necessity, and the energetic projector, I am pleased to say, is sanguine, and laboring night and day for its success, and it is to be regretted that the work is not progressing to-day, for the cost of pumping increases with every foot of descent. It must be very rich ore indeed to pay for going down much deeper. When the tunnel is completed, the pumps will be discarded, and the outlay for pumping go into the pockets of the stockholders instead of floating down Six-Mile Cañon.

In the Sixth Annual Report of the Gould & Curry Silver Mining Company for 1865, its President, Alpheus Bull, says:

"Drainage by the natural flow of the water whereby the expense of pumping would be saved, and good ventilation whereby the timber would be preserved and the efficiency of the workmen in the mine greatly increased, are so important that they warrant me in urging upon your attention the proposition of the "Sutro Tunnel Company," which offers to run a tunnel from the mouth of Webber Cañon to strike the Comstock Lode one thousand nine hundred feet beneath our croppings, on condition that the mining companies will pay a certain sum of money, to be agreed upon, for every ton of ore taken from the mines after the tunnel has drained them.

I am heartily in favor of this company doing all it can consistently to encourage the execution of this enterprise, which, in my opinion, is of the utmost importance for the profitable working of all the mines on the Lode.'

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Extract from the Report of S. P. Dewey, Esq., President of the Empire Mill and Mining Company, San Francisco, December 19, 1866.

SUTRO TUNNEL.

I deem it my duty to bring to the favorable consideration of the stockholders of this company, that great, and (for the interests of the Washoe Mines) indispensably necessary work, "the Sutro Tunnel." I may truly say *it is the one great prospective want of those mines*, and should receive at our hands every possible aid and encouragement. *No time should be lost in urging the commencement of the work*, as experience has shown that with the increased depth which our mines will have reached before the tunnel can possibly be completed, the expense of mining through independent shafts will have become so large as to consume all and more than all the product. The result is, therefore, inevitable, *the Sutro Tunnel, or some similar work must be constructed, or the mines must be abandoned* at a depth of 1,800 or 2,000 feet.

Were that work constructed to-day, the expense to the companies running through it, under the terms of the contract already entered into, would not be more than fifty per cent. on present cost from their lower levels; while at the depth at which that tunnel will strike the ledge, the difference would be immensely greater—probably not more than ten to twenty per cent. on the cost of working through an independent shaft.

The President of the Savage Mining Company, Alpheus Bull, Esq., says, in the Annual Report to that Company for 1866:

"The importance of affording drainage to the mine at a great depth, if it can possibly be obtained, cannot be too highly estimated. The Sutro Tunnel Company is the only party who proposes to undertake this important enterprise, and your Trustees have entered into a contract with that company for the purpose of effecting this great object. It is much to be desired that success will attend the effort, for it is, in my opinion, a work upon which depends the future value and profitable working of the mines of the Comstock Lode. I recommend that this contract be ratified by the stockholders at their present meeting."

Extract from the Report of the State Mineralogist of Nevada, R. H. Stretch, Esq., for 1866.

SUTRO DRAIN TUNNEL.

The main features of this enterprise are now so well known to the public that it is not necessary to repeat them here. A sketch of the enterprise will be found in the Annual Report of the Surveyor General of Nevada for 1866, p. 56, and the publications of the company give all the minutiæ of the contemplated operations. The section of the Comstock Lode, and the topographical map of the country beneath which the tunnel will pass, are valuable additions to our knowledge of these mining districts. *Of the immense value of the Sutro Tunnel to the mines on the Comstock Lode there can be no doubt*, and it is gratifying to find that the unwearied efforts of the projector are likely to be crowned with success. Probably no mining locality possesses greater facilities for deep drainage; indeed, Nevada is admirably situated in this respect, its mineral-bearing mountain ranges being usually lofty and precipitous, with an average width at the base of from ten to twelve miles only.

In the "Seventh Annual Report of the Gould & Curry Silver Mining Company, San Francisco, 1866," the President of that Company, Mr. Alpheus Bull, says:

"Believing it to be of vast advantage to the future of silver mining in Nevada, I recommended a year ago, that the Trustees of this company be authorized to enter into a contract with the Sutro Tunnel Company, so as

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to aid in the accomplishment of that undertaking: by means of it to secure deep drainage and good ventilation to the mines on the Comstock Lode. This contract was duly entered into and properly executed; but, for reasons unnecessary to detail, the funds have not yet been obtained on the part of the "Tunnel Company:" hence, the work has not been commenced.

Parties chiefly interested in this enterprise are now soliciting the mining companies with whom they have contracts to become interested in the "Tunnel Company," and are urged to do so by having presented to them the prospective benefits they are expected to derive from it. It appears to have been forgotten by the projectors of this tunnel, that it was in view of these prospective benefits that this company engaged and bound itself in a contract with the Tunnel Company, *which, for extended liberality, I consider is entirely unprecedented.* At the time of making this contract I was conscious of the onerous conditions the Company was assuming; but determined, notwithstanding this, that the Tunnel Company should be clothed with such benefits, and should present so bright a prospect of a successful career, that there would be no hesitation on the part of capitalists in embarking readily in the adventure, and thus secure its accomplishment.

That I have not been mistaken in my estimation as to the magnitude and great liberality contained in this contract, a late exposition on the part of the Tunnel Company affords abundant evidence. In a pamphlet issued in September last, it is shown with convincing evidence, that the revenue to be derived from it will be nearly $2,500,000 per annum, while, at the same time, they will derive from the sales of other property, over $3,000,000. With this enormous exhibit of ultimate profit, (and, in my judgment, not over estimated, if the lode proves to be continuously mineral-bearing,) it is remarkable that the Tunnel Company should fail to command the confidence of capitalists where capital abounds; the mining companies cannot afford to furnish the requisite means in a *country where capital is scarce and high priced.*

From the "Daily Union," Virginia, Nevada, February 7, 1865.

A GREAT PROJECT.

Senate bill No. 130, introduced by Senator Winton in the Senate on the 23d ult., having passed both Houses was, Friday, signed by the Governor and has become a law. This bill provides for constructing a mining and draining tunnel at a point to be selected in the foot hills of Carson River Valley, near Dayton, between Corral and Webber Cañons; running thence in a direct line to the Comstock Lode. Also for the sinking of shafts along the line of said tunnel, and for the development of other lodes through which it may pass. The necessity of a work of this character will be apparent to all who know the great difficulties that are multiplying in the continued extraction of ore from the claims on the Comstock Lode, which difficulties must continue to increase as work progresses. This tunnel will be, when it reaches the Comstock Lode, 3¾ miles in length, by actual survey, will strike the said lode at a depth of (2,000) two thousand feet, draining all the intervening mines and developing a large scope of country, supposed to possess great mineral wealth, and enable the work upon the principal mines in Virginia to proceed without embarrassment for many years. This enterprise commends itself to the good wishes of the citizens of Virginia and of the entire State, and its importance can scarcely be over estimated.

From the "Advantages and Necessity of a Deep Drain Tunnel for the Great Comstock Lode," San Francisco, February, 1865. Page 19.

The necessity of completing this tunnel, without delay, must be apparent to every one who reads these pages attentively, and gives this important subject the attention it deserves. No time ought to be lost to commence operations at once, and to push the same with the greatest energy, day and night, until completed. By the time this work can possibly be finished, *the decline of our mining interests, and all other interests in Nevada, will fairly have commenced.* If this matter is delayed until the mines cannot be worked any deeper by machinery, the country will go to ruin, waiting for a drain tunnel to be completed.

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Much has been spoken and written about the importance of a rail road across the mountains; it has been the subject of discussion in the newspapers, in the halls of the Legislature, and in Congress, for a number of years past. It is certainly a subject of great interest to the people of Nevada and California. *But this tunnel is of still greater importance, for we venture to say, that but few people would be in Nevada by the time a railroad is finished, if this tunnel is not constructed.*

FROM THE SAN FRANCISCO "DAILY EVENING BULLETIN," MARCH 9, 1865.

THE PROJECT TO DRAIN THE COMSTOCK LEDGE.

Adolph Sutro, well known in this city, and who for some years back has been engaged in mining operations on the Eastern Slope, has just printed a pamphlet, for private circulation, entitled "The Advantages and Necessity of a Deep Drain Tunnel for the Great Comstock Ledge." We have already called the attention of our readers to this project. There is something magnificent in the scheme, and there is no doubt that it will prove of immense benefit to our mining interests. * * * * * * * * * *

The object of this vast undertaking is the drainage of the entire Comstock Ledge, without which the mines are worthless. By means of pumping, mines exceeding 1,800 feet in depth may be drained, but the expense is enormous. It is claimed by the projector of this tunnel that the same work can be accomplished at far less cost by his scheme, which also has numerous other advantages to recommend it. He enters into elaborate calculations tending to show that the cost of pumping the estimated water on the ledge from a depth of 1,800 feet, would amount to from $4,000,000 to $5,500,000 per annum.

Mr. Sutro urges, that no time ought to be lost to commence operations at once, and push the same with the greatest energy, day and night, until completed. * * * * * * * * *

FROM THE "DAILY UNION," VIRGINIA, NEVADA, MARCH 10, 1865.

SUTRO'S DRAIN TUNNEL.

Most of our readers have, doubtless, heard of the franchise granted by the Legislature of this State to A. Sutro, Esq., of Dayton, for running a drain tunnel from a point about three miles north of that town to the Comstock Lode in this city. *It is one of the grandest projects ever undertaken on this continent*, and its importance to the people of this State, and the owners of the Comstock Lode in particular, cannot be over-estimated. As the mines reach a greater depth the expense of drainage by pumping increases so rapidly that it would, probably, in five years from now, absorb nearly all the proceeds of our best mines, which now go to the payment of dividends. Hence, it is a *necessity of the State*, as urgent as the necessity to have a railroad to tide-water, to have a deep drain tunnel for the Comstock Ledge, such as Mr. Sutro proposes. We have received a prospectus of this project, which presents all the data and information upon which it is founded, and we propose to give a brief synopsis of the same, to convey to the public some idea of the character and importance of the undertaking. * *

Mr. Sutro proposes that the parties to be benefited by the drainage of their claims shall pay, from the time they begin to derive a benefit from it, (after its completion,) a price not to exceed two dollars per ton on every ton of ore raised and sent to the mills. This, together with such discoveries as he may make on the route, and the water draining from the tunnel, will constitute the remuneration or return for the investment. For the sake of the interests of the State, as well as of Mr. Sutro, we wish the scheme entire success.

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FROM THE "DAILY ALTA CALIFORNIA," SAN FRANCISCO, MARCH 12TH, 1865.

THE GREAT DRAIN TUNNEL FOR THE COMSTOCK LODE.

The question of the Comstock Drain Tunnel will soon be submitted, in a practical form, to the companies which own claims on the Comstock Lode. Mr. Sutro, who holds the franchise for the tunnel, and owns the land where the mouth should be, is now here for the purpose of making a contract upon which he can go into the European money market and obtain the funds necessary for the work. We understand that he will probably issue a circular to all the companies interested, requesting each to select one person to represent the company in a meeting, which will appoint a committee to examine the question of drainage generally, and his proposition especially. This request can scarcely be denied by any company, for the importance of drainage is universally admitted. It is estimated that, so soon as the tunnel becomes a certainty, the market value of the Virginia and Gold Hill mines will advance at least twenty per cent., the total advance being more than the entire expense of the tunnel; and, if rich deposits should be found in a claim, at the depth of 1,800 feet, the value of that claim would immediately be quadrupled.

The tunnel would in so many ways, reduce the expenses of timbering and mining, and increase the facilities for extracting ore, and by strengthening confidence, encourage new workings, that the amount of mineral reduced would be doubled. The magnitude of the undertaking would be eclipsed by the splendid results. Washoe, which is already the greatest of silver mining districts, would rise to still higher eminence in the world of enterprise, industry and finance.

FROM "VIRGINIA UNION," APRIL 10TH, 1865.

SUTRO'S DRAIN TUNNEL.

The importance of the commencement as well as the completion of this great undertaking is acknowledged by every one, and particularly by such as are acquainted with the mines around Virginia, and the immense sum it costs to pump out the increasing quantities of water. That excellent paper, the Mining and Scientific Press of San Francisco, speaks flatteringly of the enterprise, and urges the mining companies interested to lose no time in accepting Mr. Sutro's liberal proposition.

FROM THE "UNION," VIRGINIA, NEVADA, JUNE, 1865.

SUTRO'S DRAIN TUNNEL.

In a conversation with Mr. Sutro, yesterday, we learned that he is getting his great enterprise into pretty good shape, many influential parties having taken hold of the matter. He may, however, have to go East before perfecting arrangements so as to commence work. This immense and extensive tunnel will be some four miles in length, and will tap the Comstock ledge at the depth of 1,800 feet from the surface, *a depth which can, from present indications, never be attained in any other way*, for, aside from the great height to which everything would have to be hoisted, it would be a matter of impossibility almost to raise the water to that height. In fact it could not be done without an expenditure equal to the product of the mines, unless the ore was far richer than any discovered. By means of this tunnel the entire ledge could be drained, and far more cheaply and completely prospected than by any other possible means. At the depth of five or six hundred feet the ledge is said to have become poor, but that is all nonsense. Even if such were the case, it would surely be best to try if it cannot be found far richer at a greater depth. The sooner the tunnel is finished to the ledge the better.

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FROM THE "EVENING NEWS," GOLD HILL, NEVADA, JUNE 29TH, 1865.

THE GREAT TUNNEL.

The great tunnel project of Mr. Sutro, we learn, has a fair prospect of being carried out. The necessity of such a great work is evident. The cost of freeing our mines from water is already enormous, and is increasing with every foot of depth which is acquired below the present level; and yet, we are only comparatively a short way down. Unless some such drainage as that proposed by Mr. Sutro, is provided, our mines will have to be shut up after they have been worked down 800 or 1,000 feet further, if not before. With such a work as he proposes to construct, completed, the mines on the Comstock Lode can be nearly as easily worked to that depth below the level of the tunnel, as they can be worked from the surface without it, in all not far from 3,000 feet.

FROM THE "DAILY UNION," VIRGINIA, NEVADA, JULY 16, 1865.

SUTRO'S DRAIN TUNNEL.

That our prosperity and the prosperity of the people of this State, and even the support of a State Government, in a great measure, are dependent upon the success of this or some similar enterprise, there can be no doubt in the mind of every intelligent, reflecting person, who has given the subject the least thought. * * *

FROM THE "EVENING NEWS," GOLD HILL, NEVADA, AUGUST 24, 1865.

THE SUTRO TUNNEL.

The Sutro Drain Tunnel is in a fair way to be soon commenced.—*Nye County News.*

That's so. We saw Mr. Sutro in Virginia City, yesterday,—had a talk with him on the subject of his great Comstock Ledge Tapper, and he gave us to understand that his drain tunnel will shortly be commenced. This will no doubt be the greatest enterprise ever undertaken in this State, and will enable the companies located on the great Comstock ledge, to bring forth millions of dollars in silver where they are now only getting tens of thousands. Almost every day's developments in our Gold Hill mines demonstrate that the deeper they go the richer is their silver harvest. But the time will come, ere the snows of many winters, when our present most flourishing mines will find their machinery inadequate to contend against what we all must know is an immense subterranean body of water in the lower depths of the Comstock. Hence, we consider, that the sooner the great Sutro Tunnel is commenced and prosecuted to completion, the better it will be for the development of the hidden wealth of the Comstock ledge.

FROM THE "DAILY ALTA CALIFORNIA," SAN FRANCISCO, OCTOBER 24, 1865.

THE BLUNDERS IN WASHOE MINING.

Common as blunders are in all occupations, it would be difficult to find any branch of business in which so much money has been squandered and so many mistakes committed, with good intentions, in a short period, as in Washoe mining. The public character of the mining companies, the vast quantities of silver which some of them obtained, and the importance of the labors of all to the prosperity of the coast, threw a strong light on their transactions, and called general attention to matters, that would have remained unknown or without interest, under other circumstances. When we consider that the Gould and Curry mine has yielded $14,000,000 and the Ophir about $7,000,000, we cannot be astonished if people look with curiosity at the management of the corporations which own them.

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With the trustees of most of the companies, the main object was not to develop the mine, but to make money out of the stock. The affairs of the companies were kept secret, the Superintendent was instructed to take out poor ore, or rich ore, as bulling or bearing was the policy; he was told to write little in his official reports, and much in his private letters; assessments were levied, or dividends promised, not with regard to the wants or capabilities of the mine, but to the interest of the trustees, and so on. All this was sharp practice, confessedly in violation of the good faith that the trustee should bear to the stockholder. And yet, pernicious as it was, it probably did far less evil than the bad management which was well meant. * * * * *

FROM THE "DAILY EVENING BULLETIN" OF SAN FRANCISCO, OCTOBER 28, 1865.

THE IMPORTANCE OF DRAIN TUNNELS IN MINING.

One of the most important lessons of mining experience is that deep mines which contain much water must, if possible, be drained by tunnels, or adits as they are called in England. Every author of note who has treated of the working of metalliferous deposits repeats the lesson, and refers to the ruinous results of neglecting it. Every old and large mining district has impressive examples. Mines full of water, and mines abandoned because the pumping costs too much, are among the commonest sights. *It is so congenial to greed, and so convenient for folly and carelessness to consume immediately the entire yield of a rich deposit of ore*, that the error of depending on pumps is and will be committed over and over again. The cutting of a drain tunnel requires confidence in the permanent productiveness of the mine, capital, and a willingness to invest it on the probability of large but not immediate profits. It implies a sacrifice of something in the present for the sake of getting twice, thrice, tenfold as much in the future. In those places where mining is conducted in the most economical and most intelligent manner, we find drain tunnels used most extensively, other things being equal. In some districts the veins are in extensive flats or in low valleys, so that there is no possibility of constructing drains; in others, the lodes are dry, or the quantity of metal is too small to pay for tunnels. Of all silver mines, those in Germany are worked with the most care, and there we find relatively the longest adits. One fourteen miles long has been run to drain the Harz silver mines in Hanover, to a depth of 1,200 feet, though the yield is only $500,000 annually. The Government of Saxony has approved a plan recommended by the ablest engineers of Freiberg to drain the mines there to a depth of 2,000 feet by a tunnel twenty-four miles long. The work has not yet been commenced, but another is under way to be eight miles long, and to strike the lode at a depth of 1,500 feet.

The engineers complain that the delay in commencing the deeper tunnel is unwise and grossly wasteful. And yet the total yield of the Frieberg mines is less than $1,000,000 on the average of years. Cornwall has many long adits for draining, of which the most remarkable is that opening at the village of Ferney Splat. It is five miles long and drains the vein to a depth of 420 feet. Some of the Cornish mines, however, are not rich enough to pay for extensive draining, and are therefore abandoned when the water becomes troublesome.

In Mexico, notwithstanding the immense veins of silver ore and the inestimable benefits that would be derived by running deep-drain tunnels, little work of that kind has been done, and Humboldt, Ward, Villefosse and Duport, all lament the blind folly and negligence of the mine owners. In the three districts of Real del Monte, Zacatecas, and Guanajuato, the loss for want of drain tunnels cannot be estimated at less than $100,000,000. The Real del Monte, one of the richest mines in Mexico, lay valueless for a long time, simply because of bad management in the drainage. The Tlalpajahua mine remained unprofitable for years because of the difficulty of pumping, and Ward advised the company to devote all their funds to the completion of a great drain tunnel, which they had commenced but did not push rapidly. It was to be a mile long, and was to strike the vein 400 feet below the old works. This adit was considered absolutely necessary for the proper management of a claim, which, under the most favorable circumstances, could not be put in the first class of mines. We read without astonishment that the rich and abundant ores of Bolaños yielded no profit to the mine owners in 1795, when we learn that 5,000 mules were constantly employed in hoisting the water. Steam pumps are costly enough, but the employment of 5,000 mules in drawing up water in buckets from a depth of 600 feet is almost incredible.

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There is no reason to wonder at the proverb that "it takes a mine to work a mine," with such economy. A vast saving in the cost of drainage might be made at Zacatecas by a tunnel four miles long, to strike the vein 1,350 feet below the surface. The works are farther down, but by the adit more than 1,000 feet of hoisting and an immense waste of money might be saved. The miners, however, cannot unite their forces to do that which all admit ought to be done. M. de Villefosse, in speaking of their conduct, uses the same tone of condemnation adopted by other authors writing of other mines which have been mismanaged in a similar way.

Intelligent men who understand arithmetic, however, need not study the success of Germany or the loss of Mexico to comprehend the advantages of drain tunnels. The water, which if pumped out from a deep mine, must be lifted, not by the single pound, but in a solid column of 1000 feet high or more, thus demanding vast power in the machinery as well as strength in the pipe, will transport itself if only a tunnel with a small descent be placed within its reach. The pump is an endless expense, surrounded by possibilities of accidents that may do great injury to the mine; the tunnel once completed, instead of being an expense, renders great benefits by facilitating ventilation, preventing the accumulation of foul air, saving the lives of the workmen, protecting their health, increasing their capacity for labor, preserving the timber, offering a cheap means of extracting the ore, and filling the minds of the mine owners with satisfaction for having adopted the most intelligent plan of arrangement, and having done what they ought to do.

The lesson taught by all other mining countries is instructive for us. We have one of the greatest metallic lodes of the world, and now without exception the most productive. We refer to the Comstock Ledge. It has already yielded $35,000,000, and it will continue to yield its treasure as long as men will work at it. It is of great width, and the rich ore is porous, so that it contains in its depth large quantities of water. The companies engaged in mining there have been compelled to pump at great expense. Several of them have spent more than $5,000 per month to keep their drifts dry, and others have not been able to succeed with all their efforts. The expense and trouble, and danger from bad ventilation, as well as insufficient drainage, must rapidly increase with the increasing depth, unless a drain tunnel be cut, and for such a work, fortunately, the formation of the country is favorable. A tunnel four miles long can be cut from the mouth of Webber Cañon, to strike the Comstock Lode 2,000 feet beneath the surface of the Gould and Curry croppings. It can be cut, and it must be cut. The productiveness of the Comstock Mines, their value in the near future, and their profits in the remote future depend upon that work. Everybody admits these facts; but people are disposed to procrastinate. They hesitate about commencing the work, or committing themselves to any plan. They act as if they wanted to sell out their stock and let somebody else bother with the drain tunnel. This will not do. The work must be undertaken, the sooner the better, and the public opinion of stockholders should urge the trustees to take prompt and energetic action.

FROM THE "DAILY EVENING BULLETIN," OF SAN FRANCISCO, OCTOBER 31, 1865.

THE NECESSITY OF A DRAIN TUNNEL ON THE COMSTOCK LODE.

The Comstock Lode can and must be drained and ventilated by a deep drain tunnel. In regard to the feasibility, there is no room for doubt. The mines are situated in a range of hills three miles and a half from the valley of Carson river, and 2,000 feet above its level; the rise from the river to the croppings being gradual, with some intervening hills and cañons. Some of these cañons, which occur at intervals of about three-quarters of a mile, are respectively 443, 980, 1,360 and 1,436 feet above the river, and from them shafts could be sunk for the purpose of hastening work on the adit. The tunnel would run through rock soft enough to be picked three-fourths of its distance. Longer, deeper, more difficult and more expensive tunnels have been cut, and this can be cut, too.

There is no question about the importance of drainage to the lode, or about its absolute necessity. If the ores of the Comstock Lode were confined to the surface, if they could be exhausted within a year or two, if the mining companies were organized for the purpose not of taking out bullion, but of allowing the trustees to speculate in stocks, if all the present proprietors intend to sell out within a month or two, if the mines are to be managed with reference only to the immediate present, and without regard for the future, then any preparation for deep

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drainage would be an unwise waste of money. But those are not the circumstances of the Comstock Lode. The vein is continuous, the ore is inexhaustible, and the companies must endeavor to put their mines on such a basis that they will yield a steady profit. Any other policy is suicidal. Capitalists in San Francisco as well as elsewhere look to the future. The present value of a mine depends, and should depend to a considerable extent, on its probable productiveness in 1870 and 1875. Men here as in older cities will willingly wait five years for the profits of their investments, provided that there is a fair prospect of a return proportionate to the interval.

There is abundant evidence on a number of points to show that the present system of hoisting the ore and water from deep shafts, is one of the chief reasons why some of the best mines are not profitable to-day. The loss will of course be vastly greater as the depth increases. The quantity of water now pumped out of the Gould and Curry mine is 75,000 gallons per hour, and some persons say that is about one-sixth of the total amount now pumped up. Let us say, however, that it is one-fourth, and then we have 300,000 gallons per hour, or 7,200,000 per day. Every company that has reached any considerable depth has a pump of its own, and many of them have never measured the quantity which they raise. The Hale and Norcross pump up about 15,000 gallons per hour, and they spend $80 per day for firewood alone, about two-thirds of their power being used for pumping. The Superintendent of the Best and Belcher estimated that his company spent $88 per day in pumping 15,000 gallons per hour from a depth of 270 feet. The Ophir, Savage, Chollar-Potosi, and all the leading Gold Hill mines have large and very costly pumps.

If the quantity of water is 300,000 gallons per hour, at a depth of 600 feet, what will it be at 2,000? Three times as much is probably a moderate estimate, which would give us 900,000 gallons per hour, or 21,600,000 gallons (86,400 tons at 8 pounds per gallon) every day. At the most moderate engineering estimate, this amount of water cannot be pumped up 2,000 feet at the Comstock mines, where fuel and labor are dear, for less than $5,000,000 annually. A. Sutro, in his pamphlet on the drainage of the Comstock mines, estimates the quantity of water 1,800 feet down at 8,000 gallons per minute, or 46,000 tons per day; but that is a very low figure, and he puts the cost of pumping it up at $4,000,000. After this statement, is any argument necessary to show the ruinous result of draining by pumps instead of a tunnel?

But unfortunately, there is no certainty that pumps will suffice. The mine that depends on them is never safe. The machinery may get out of order, the wall of the shaft may cave in and break or disjoint the pipes, or the miners may strike some large reservoir of water, hidden in the vein, and then the works are flooded, and perhaps vast damage is done with no possibility of prevention. Such accidents have often occurred, and the liability of all mines to their occurrence causes much expense. The Gould & Curry Company, which has a pump with pipes a foot in diameter, is now putting in another of the same size, not for ordinary use, but as a safeguard against accident.

The system of draining by pumps prevents the development of a vein. The deepest shaft has the most water, and therefore it is the interest of each company to hold back until its neighbors have gone ahead and drained the lode; but as the expense of this drainage is very great, the company which is down lower than the other in the same vicinity will often be unable to proceed with profit, and therefore will stop work. The question will be then whether this company or that one can afford to remain idle the longer. If there were open galleries, or channels, communicating with all parts of the vein, there might be perfect drainage through one shaft; but it frequently happens that the draining of a shaft has little influence upon the water in another only a few hundred feet distant. This is one of many reasons why the companies cannot unite to drain the lode by pumps.

If, however, there were no water in the lode, and if a deep tunnel were of no value for draining the Comstock Lode, it would pay merely for the sake of ventilation, without which the heat becomes terrible in the deep drifts, the air is foul and dangerous, the men cannot do half the work, the timbers rot with great rapidtly, and the expenses are sometimes ten times more than they would be with good air.

From the "Daily Alta California," San Francisco, Nov. 6, 1865.

VENTILATION OF THE WASHOE MINES.

Scarcely a week passes that we do not hear some st atement from Virginia City about the slowness of work in the mines, on account of bad air, and sometimes there is a total stoppage for weeks in the lower drifts for the same reason. The same evil is felt in all the deeper mines, though it increases with the depth and distance from

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the main shaft. The breathing of the miners, the burning of the candles, the smoke of the powder used in blasting, the decomposition of minerals, containing sulphur, carbon and nitrogen, tend to poison the air until it becomes dangerous to life in the low, narrow drifts, scarcely large enough to let a man handle his pick. Carbonic acid gas, the "choke damp" of the mines, is heavier than pure air, and when it once takes possession of a mine, has a tendency to remain there. The closeness of the atmosphere is not merely inconvenient but dangerous to the miner, and costly to the mine owner. In Devonshire fifty-two per cent. of the miners die by consumption, chiefly because of bad ventilation. The figure is so large that suspicion arises that it must be incorrect, but we find it reported by Scoffern, a respectable and well informed author, who tells us that one of the first duties of the mine-owner, who has a permanent vein and a rich deposit of ore, is to provide abundant ventilation. The same author tells us that there have been instances where breathing was so difficult that a man could not do one-tenth as much work as in the open air, and as a consequence the mine-owner had to pay ten times as much for cutting drifts and taking out ore as in well ventilated mines. In some mines there have been relays of men, to relieve each other at intervals of five minutes, and if a miner attempted to stay fifteen minutes in a close drift he felt like fainting.

FROM THE "DAILY EVENING BULLETIN," SAN FRANCISCO, NOV. 6, 1865.

* * * * "Not only the welfare of California, but we might almost say the very existence of Nevada as a State, depends on the permanent productiveness of the Comstock Lode. The report of the Comptroller of Nevada for the fiscal year ending May 1st, 1865 showed, that the entire taxable property of the State was assessed at $29,737,376, of which Storey had $15,316,309, Washoe $2,810,800, Lyon $2,847,663, Ormsby $2,088,657, and Douglas $1,174,631, a total of $24,238,061, or five-sixths of the total taxable property of the State. These five counties are all in the immediate vicinity of the Comstock Lode, which furnishes employment directly or indirectly to most of their inhabitants. Although the ore comes from a narrow vein two miles long, the mills which reduce it are scattered about at distances of ten or fifteen miles, and men who dwell still farther off are employed in cutting or hauling timber, hauling ore or supplies, cultivating vegetables for them and so on. The production of $15,000,000 in silver, the larger part of which goes as wages to the workmen, must, of course, be a very important item in a State, which has a population of only 30,000 or thereabouts. When Potosi of South America yielded $10,000,000 annually, a population of 160,000 collected in the city, if the tradition is to be trusted, for the place has no authentic history. It will not be easy to find any other place in the world outside of Nevada, where a population of 30,000 produce $500 to the person; and this vast production, coming almost entirely from the Comstock Lode, shows that the existence of the State depends at present on that lode, though there are, no doubt, numerous other rich lodes, which will become productive in the progress of time. *But if the mines at Virginia and Gold Hill were rendered valueless now*, the *State would be bankrupted.* Precisely as confidence rises in the permanence and steady increase of the productiveness of the mines, in that same ratio the value of property, the credit of the State, and the value of its bonds will rise; and as the confidence fails, so will the State credit. * * * * * * * * * * * *

THE SOUND OF THE FIRST PICK STRUCK AT THE SUTRO DRAIN TUNNEL, or in a tunnel by any other name which promises to as thoroughly drain the Comstock Lode, should cause renewed confidence in every man, who identifies his fortunes with those of California. It will stiffen the backbone of Montgomery street; Front street will get an impulse from it; the farmer will plant more fruit trees and vines, knowing that he is now secure of a permanent market; the Pacific Railroad Company will have additional inducements to hurry up their work; and everybody will feel more confident of the steady increase of the population and wealth of the coast. But on the other hand, if we know, that the Washoe Companies cannot work together, and that each Company must depend upon its pumps, and that the companies hitherto unsuccessful are to abandon explorations, then everything will retrograde.

FROM THE "DAILY ALTA CALIFORNIA," SAN FRANCISCO, NOVEMBER 9, 1865.

THE INEXHAUSTIBILITY OF THE COMSTOCK LODE.

One of the most important lessons of mining experience, taught by all the principal authorities, is that true fissure lodes are continuous geologically and inexhaustible practically, although a point may be reached where the

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extraction of ore ceases to be profitable. A true vein, according to Prof. Whitney, is "a fissure in the solid crust of the earth of indefinite length or depth, which has been filled more or less perfectly with mineral substances, or in other words, an aggregation of mineral matter, accompanied by metalliferous ores, within a crevice or fissure which had its origin in some deep-seated cause, and may be presumed to extend for an indefinite distance downwards."

According to the theory accepted by geologists generally, the fissure was made by some internal convulsion, and while it stood open it was filled up with the veinstone, the ores coming up in vapors from the intensely hot regions below, and crystallizing or condensing in the vein. This theory implies continuity in the vein, and inexhaustibility in the mineral. The fissure veins always have a veinstone differing in geological character from the walls, which are usually distinctly marked.

Thickness of lode, steepness of dip, distinctness and hardness of wall-rock, difference in character of the two walls, difference in character of the wall at different parts of the vein, occurrence of horses similar in geological character to the hanging wall, and clay seams that appear to have been formed by the grinding of the veinstone against the walls, are all important evidences of a true fissure vein. All these evidences are found in the Comstock Lode, the wall of which is a hornblendic porphyry on one side and a feldspathic porphyry on the other, accompanied in places by trap. The feldspathic porphyry is found in the vicinity of most of the great silver lodes, and its presence as a wall-rock is considered a most favorable indication of the continuity of the vein in Spanish America.

All the great silver lodes now producing any considerable amount of metal, are considered to be true fissure veins. The mines at Cerro Pasco, in Peru, have been worked since 1643, have yielded $450,000,000 and are still productive. The Potosi mines, opened in 1545, have contributed $1,200,000,000 to commerce and are not yet exhausted. The mines of Guanajuato and Zacatecas have been worked about three centuries, and together they have yielded more silver than Potosi, and they are still among the most productive of the world. Alamos in Sonora, has been an important silver mining district for two hundred years. The mine of Guadalupe y Calvo in Chihuahua, though it has been worked thirty years, yielding in some years as much as $1,000,000 is not yet abandoned. The mines of Sombrerete, discovered in 1670, were worked with great profit, one of them yielding $20,000 per day for five years, until 1698, when they were closed by a lawsuit, and then rendered inaccessible by the accumulation of water. Thus they remained for nearly one hundred years, until a bold man came along, reopened them, and took out in a few years $13,000,000; and the mines there are still considered to be rich. Santa Eulalia, in Chihuahua was worked for eighty years and was then abandoned, not because of exhaustion, but on account of the hostility of the Indians. Chañarcillo in Chile, has yielded about $2,000,000 annually, for more than thirty years, and no one anticipates any interruption of its productiveness in our time. Real del Monte is rich to-day, though it has been prominent for its production of silver since the middle of the sixteenth century, with no interruptions save those caused by water and the want of drain tunnels. The silver mines of Hanover and Saxony are not exhausted, though they have been worked since the middle ages. Nine-tenths of the silver yield of Spanish America and Europe comes from veins that were opened more than two hundred years ago, and have been profitable ever since. Not one of them has the features of continuity more strongly marked than the Comstock Lode, and few of them promise to yield more silver. Some are wider, others have been traced farther, and others have richer ore, but no other has produced $35,000,000 within three years, or has been worked with so much energy, or offers such facilities for deep draining, ventilation and the extraction of the ore.

From the Financial and Commercial Article of the Alta California, San Francisco, Nov. 27, '65.

The Mining shares droop, and it has become very evident that a new shuffle must take place with the mine themselves. Unless such a state of affairs presents itself at the mines as will give some public assurance of more profitable operation, the Nevada companies will fall "to cureless ruin." This matter should engage the attention of stockholders at the annual meetings now about to take place. The old system of humbugging promises

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on the part of some directors, who are expert stock gamblers, but utterly incompetent business men, has been "played out." Nevertheless, a handsome property exists there, and the proposition is to make it available. The facts seem to be these: On a ledge running four miles are a row of mines, which have worked through a belt of ore of great richness. At least one-half the proceeds has been lost by the most abominable misconduct. At the depths of three hundred to six hundred feet the row of shafts work in poor ore, at such increased expense, by reason of the great depth, that more than all the proceeds are used up in the operation. To sink deeper increases the expense in an arithmetical progression; consequently, the ore should increase in richness to pay. If ore is found at those greater depths as rich as that got out near the surface, it will not pay, owing to the greater expense of hoisting, clearing water, timbering, new machinery, etc., made necessary by the greater depths. Nevertheless, all authorities agree that the ore does increase in richness at great depths. Now, it is proposed to organize a company which shall drive a tunnel parallel with the row of mines, and which shall run under the present works at a depth of 2,000 feet, in the same way that a sewer runs lengthwise of the streets. The first effect of the tunnel will be complete drainage of all the mines, so that flooding and water pumping will become unknown. The next will be that hoisting ore will no longer be necessary, but as the tunnel passes through the vein of each company, it will receive the ore dropped from above, and which will be carried by its own weight on tram cars to the mouth of the tunnel, without cartage or rehandling. There the company owns ample lands, to be occupied by each company with its own works for the reduction of its own ores. The full cars run out on one track and the empty ones return on the other.

FROM THE "ALTA CALIFORNIA," SAN FRANCISCO, DECEMBER 18, 1865.

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The cutting of a deep tunnel to drain the Comstock Lode, is an enterprise to which everybody who owns a share of Washoe stock should give his influence. *The tunnel is a necessity.* Without it many of the claims must be abandoned, *for the want of it many are now idle*, and all are working at an unwise expense, and are prevented from making the explorations which are the only means of maintaining the steady production of bullion.

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FROM THE SAN FRANCISCO NEWS LETTER, APRIL 14, 1866.

For every reason, the great undertaking of Mr. Sutro deserves our warmest support and to be strenuously upheld by the companies owning claims on the Comstock Lode. The prosperity of these mines is not only of vital necessity to their proprietors, but is of the first importance to the whole mercantile interests of this State as well as the State of Nevada. Let their works stop, and the paralysis will extend to us here. That they will stop, unless they can be kept clear of water, is abundantly proved by the Tantalus-like condition of some of the mines that, with rich ore in view, cannot get at it on account of their works being flooded. The great Sutro Tunnel remedies this evil, and the day that its last gallery reaches the intersection of the Comstock Lode, far away below the ground, will be a day to mark with white in the calendar of Nevada, for it will be the inauguration of life, activity, riches and health, to those mines which, without it, will be decayed, dangerous, unproductive and abandoned. It behooves us all to aid, to the best of our ability, in assisting the Sutro Tunnel Company in their great enterprise; and the capitalists of New York, whose interests are so much incorporated with those of our State, would do well to take the matter under serious advisement. Wall-street operators may therein find it to their benefit to forward this enterprise, which has real stability and assured profit, as the contracts with the great companies of Nevada abundantly prove. Immediately on the completion of the tunnel, these companies have engaged themselves to pay a percentage on their returns which will amply reward any investor in the undertaking.

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From the Virginia "Daily Union," of April 26, 1866.

Arrived.—A. Sutro, one of the principal owners of the contemplated Sutro Tunnel to the Comstock Lode, arrived in town on Tuesday. He is here for the purpose of perfecting the necessary arrangements for pushing the work along. We understand that he will leave for the East by the next steamer, in hopes of being able to enlist eastern capitalists interested in this stupendous piece of work, and the greatest and most beneficial work ever attempted in the State, we wish him luck.

From the "Daily Union," May 8, 1866.

A. Sutro, Esq., will proceed to London by the outgoing steamer, for the purpose of laying before the capitalists of Europe the merits of the project for draining the Comstock Lode by means of the "Sutro Tunnel." About $3,000,000 will be required to carry through the enterprise. Mr. Sutro departs upon his mission with the strongest indorsements of all the most wealthy and sagacious men connected with the mining interests of this State.

From the "Daily Morning Call," May 9, 1866.

Great Enterprise.—Adolph Sutro, Esq., of the Sutro Tunnel enterprise, near Virginia City, will proceed East to-morrow for the purpose of interesting eastern capital in his great work. It is calculated that the completion of this tunnel will add fully fifty per cent. to the yield of the mines on the Comstock Ledge, besides materially reducing the expenses of working them. When completed, it will be of immense benefit to Nevada and California, and doubtless very profitable to those engaged in the enterprise.

From "The Daily Carson Appeal," May 1, 1866.

SUTRO'S TUNNEL.

Mr. Adolph Sutro came here last Saturday, to get certain stamps and seals attached to the ponderous parchment "Articles of Agreement" which have been drawn up between the Trustees of the great Sutro Tunnel Company and the several mining companies on the Comstock Ledge. Mr. Sutro has displayed the most untiring energy and perseverance in arranging the preliminaries for the commencement of the stupendous undertaking, of which he is the originator and prime mover. The parchment, to which we have alluded, is an immense affair, being quite as large as the full size of the paper upon which the Sacramento Union is printed, and there are more than one hundred of them. Indeed, they appear like royal commissions, bespangled as they are by seals and stamps. Mr. Sutro will leave San Francisco for New York on the steamer of the 10th inst., and after transacting certain necessary business in Washington, will proceed to London, in which city, as he feels fully assured, he will be enabled to negotiate the advancement of the requisite capital for the prosecution of the work which he has in view. He expects to raise three million dollars, and we are led to believe he will be successful. There is probably no project which the State has so much to hope from as the early building of the Sutro Tunnel. Once constructed, and the permanence of the Comstock Ledge, as a source of vast revenue, is established beyond a possibility of doubt. Without it the business of mining at great depths will have to be abandoned before the expiration of ten years. *Success to Sutro is success to Nevada.*

From the "Alta California," San Francisco, of May 10, 1866.

Eastward Bound.—Among the passengers who leave our city to-day is Adolph Sutro, the author of the Sutro Tunnel project, and the leader in the organization of the company. He goes for the purpose of obtaining from the capitalists in New York or London the capital necessary for the great work.

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Everything that is necessary has been done here. The Legislature has granted a franchise for the enterprise; the company has been formed of business men of high standing in Virginia City; the public are satisfied that the plan is the only practicable one for draining the Comstock Lode properly; mining engineers and geologists say the lode will pay for draining and must be drained; and the great mining companies on the lode, representing 95 per cent. of its value, so far as ascertained, and representing also much of the best financial and scientific ability and experience of this coast, have approved the plan and accepted the contract which was drawn by some of the best lawyers of San Francisco. Everything has been done after the most careful deliberation; the magnitude of the interests involved forbade haste. All has been done here save supplying the capital; that we have not to spare, our rates of interest are too high; our large capitalists are too few. Gentlemen familiar with the financial and industrial character of the project and with the London money market say the money can be obtained there, and we trust that their opinion will be verified by the fact, and that the enterprise will prove a success to all who may engage in it, as there is reason to believe that it will.

From the Financial and Commercial Article of the Alta California, San Francisco, Dec. 10, 1866.

The great tunnel proposed maay months since, gains daily on the convictions of all parties. That work proposes coming west four miles from Carson, to enter the side of the mountain two thousand feet deep. A drift of two miles each way, north and south, will run under each mine, thereby draining them effectually, and giving a downward outlet to the ore, at once abolishing all hoisting and putting an end to its expense. An idea of the importance of this may be approximated:

Product of lode for 1866,		$16,000,000
Dividends paid,	$2,000,000	
Assessments levied,	1,500,000	
		500,000
Expense mining,		$15,500,000

Of this immense sum, nearly two-thirds is spent in hoisting ore and water. The tunnel proposes to allow the water to run off by itself from the mines, but it will be sold by the Tunnel Company for mill power. The ore will descend of its own weight, and pumps, engines, reels, wire rope, iron buckets, etc., will be measurably abolished, with the terrible expense of $16 gold, per cord for wood to keep them in action. The result may be on the same production of ore $8,000,000 dividends to stockholders, instead of $500,000, but the production of ore will be immensely greater as the depth increases.

From the "Daily Times," San Francisco, Dec 15, 1866.

THE SUTRO TUNNEL.

Eds. Times:—This great enterprise has not yet been launched, although it seems next to an impossibility that it should not be taken up very speedily. As our readers know, the project is to work a tunnel the length of the Comstock Lode, connecting all the mines at a depth of 2,000 feet; when any one reflects upon it, he becomes utterly surprised that there should be a moment's hesitation in respect to it. The success of the undertaking is guaranteed by some thirty mines, whose aggregate length is about 26,000 feet. These mines have each of them been started at a venture, and the necessary money was paid in on a mere chance of finding ore. Nearly all of them found it, and they have raised in the aggregate $52,000,000 of treasure out of those thirty holes. These mines have been worked at great disadvantage, struggling expensively against water and the cost of fuel. They have all demonstrated the fact that the ore is there, that it grows more permanent as they go deeper, and also that the expense of hoisting water and ore will increase as they go down. In this situation of affairs a company comes forward and offers to give them an outlet 1,500 feet lower than their present depth, and not only to relieve

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them of a large proportion of what they now expend for hoisting, and to do it on this sole condition, that they will advance a small portion of the money which their reduced drainage will cost. Thus, we estimate that of the $16,000,000 now annually produced, $4,000,000 is expended for fuel at $16 per cord, to drive engines and hoisting water and ore, and for transportation, which would be dispensed with on the construction of the tunnel, and the same service performed for $1,350,000, effecting a saving of $2,450,000.

The Tunnel Company ask only an advance of a small portion of that money *pro rata* per month, as the tunnel goes on. Only $400,000 is required; the rest will be taken at the East. This is only one and perhaps the least benefit the companies would derive from the deep outlet. The mines would drain themselves, the free ventilation would preserve health, and save great expense in rotting timbers. The great advantages would be the prospecting of the mountains at such a great depth, at such little cost.

If, as all engineers assert and experience confirms, the vein improves at the greater depths, and is struck by the tunnel drifts, all the mines so tested will have a value far above the wildest calculations of the most sanguine adventurers now.

NEVADA.

From the "San Francisco News Letter," Dec. 15, 1866.

WE SOLEMNLY OBJECT TO THE SUTRO TUNNEL.

We have got a budget—a budget of objections—of objections to the Sutro Tunnel. We hasten to lay it before our readers. It has cost us time and labor to get it together. We cannot brag much of the company we found it in, but that is neither here nor there. We could say something more of the enterprise we have laid out in making our collection, but we prefer not to. Its value we leave to the judgment of our readers. Without intending to say that they are "rummy" objections, we may indulge in a simile. As shone Bardolph's nose when he was seen to run up Gadshill by night, so luminous shine they forth. We lay out our collection, item by item. So here is our budget of

OBJECTIONS.

1. "It will drain the wells of the mining towns." This reminds us of a little story: Once on a time a very bad road connected two towns, between which there was much travel. The road was bad to begin with, and as nobody mended it, and it did not mend itself, it grew no better every summer and worse every winter. Teams kept breaking down on it in the most lively way, and blacksmith shops arose and thickened along the route, and became a very cheerful feature of the landscape. A great complaint at last went up on the part of the traveling public, and the selectmen proposed to get the road mended. The blacksmiths put their heads together and came up in full force with *their* budget of objections. They set forth their grievances at great length, and wound up with a solemn protest against mending the road. The rest of the story we have forgotten.

2. "There is no security that the work will be carried out." Quite true, nobody proposes to enter into bonds. If old Comstock had waited for bonds before he put his pick into the ground, he would have been waiting yet. If we refuse to clothe and educate the boy until we see whether he is going to live to grow up, he will not be fit for much when he is a man. If we will not prospect a mine until we have made a fortune out of it; if we will not go into the water until we learn to swim; if we will not take the first step until we are within sight of the end of our journey—then life would be a very short horse and soon curried. We have to act in all things on reasonable chances. Mining is a risk of itself, and the risk is somewhat in the ratio of its enormous profits. If there is a motive to begin the tunnel, how much stronger is it to finish it. Fancy it done, a glorious fact, then look back and see how small such objections will look, and how miserably paltry those will look that cast them up.

3. "Some of the companies will stay out." Of course they will. Some of them have staid out so long they can't come in. That is just what's the matter. They have lived too fast. Their parents are rich (as Billy Birch would say) but they have worn out their good clothes, and got seedy and run out, and their uncle refuses to see them any more. They have used up their regular allowance, and have to wait for the next quarter day—when the tunnel arrives—and they will be in funds again. Meantime, all they can expect to do is to scratch round and try to make a decent appearance. Their solid heaps of guineas are in the tunnel.

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4. "It is going to be a big thing for the Tunnel Company." We wouldn't wonder. That alarming fact is likely to be true. If that is proved on the company we abandon that concern to the underwriters. Of course that would be a serious drawback to the chances of carrying out the project. How would the mines stand? They are paying at Virginia $50 per miner's inch for water, which the tunnel will furnish in abundance at small cost; three-fourths of the whole Comstock Lode, now out of ore, will be brought into ore; 4,000,000 tons of ore in sight will then be profitably worked that cannot now be; from $5 to $7 per ton will be saved on the present cost of getting ore out; and the yearly production will be increased from $16,000,000 to $50,000,000. These are some of the advantages the miners will get to compensate for the damage they suffer from the Tunnel Company making money. Pity it will not run the tunnel on an entirely business basis for nothing.

5. "The companies have no right to subscribe." Who says so? Who stands sponsor for this legal proposition? Not lawyers, for they laugh at it. If the mines have the right to pay for unnecessary work they have likely a right to pay for what is necessary. The subscription is called a loan and this it is. But if the companies have a right to spend their money and not get it back, they have as good a right to spend it where they are sure of getting it back. The money will be advanced on an existing contract, and will be pay in advance for drainage and use of the tunnel. Can a mining company advance money on a contract for a steam engine? We think so. But if there are attorneys at law who say not, we want them to put that down in black and white, and sign it, and be sure and let us know where they hang their shingles out.

So much for our bundle of objections. We intended giving a chapter on the objectors themselves, but cannot do it now. Besides, we do not know whether our readers are provided with magnifying glasses sufficiently strong to follow our description. We brought several of the species under a powerful lens, and could see them and their little structure quite distinctly. We will describe them hereafter if they should continue to deserve as well at our hands.

FROM THE DAILY ALTA CALIFORNIA, SAN FRANCISCO, SATURDAY, DECEMBER 15.

FINANCIAL AND COMMERCIAL.

This matter of ventilation is one the importance of which is not generally appreciated. Thus, it is known that the temperature of the air increases one degree of Fahrenheit for every sixty feet of descent into the earth, all over the world. Thus, supposing the temperature at the surface of a Comstock mine to be sixty degrees, at the present depth of 700 feet the thermometer should mark 71, but the operations of a number of men in a few feet square, lighted by a number of lamps, which consume air, raises the temperature. Accordingly, it is found that the actual range of the thermometer is 85@100 in the Comstock Lode at 700 feet. Following the same rule, a further descent of 700 feet will raise the temperature to 110. A descent to the proposed level of the tunnel will give an atmosphere of 120 for miners to work in, and few will expect much labor under such a pressure. Now, it requires no argument to show that the labor of a man in an atmosphere of 100 degrees cannot be as efficient as when the range is only 60 degrees, and the quantity of light that can be used is not limited by the necessities of respiration. It has been ascertained by careful investigation that at 90 degrees labor is less efficient by 33⅓ per cent. than it is at 65. In the operation of the Mount Cenis Tunnel, the first condition of its practicability was to create a circulation of air. This led to the invention by which air condensed to six atmospheres is forced in by pipes. This air operates the drills, and at the same time keeps up a full ventilation. Ventilation in mines may be supplied imperfectly by adits, in many expensive modes. The Sutro Tunnel will supply all the mines with air at the same temperature as that on the surface. It is computed that 3,000 miners are employed on the Comstock Lode, at an average of $3½ per day, making $3,780,000 per annum. If the tunnel by improving the ventilation, will add 33⅓ per cent. to the efficiency of their labor, that item alone would pay the cost of it in two years, but the saving in retimbering the shafts and drifts is also an immense item, which added to the other considerations have made any further delay in the prosecution of the work suicidal.

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From the Daily Alta California, San Francisco, Friday, December 21.

FINANCIAL AND COMMERCIAL.

A correspondent, who seems impressed with the importance, nay the absolute necessity for the construction of the Sutro Tunnel, urges the want of what he calls a "guarantee" that the work will be prosecuted. It is rather a novelty to propose that guarantees shall be given for the prosecution of an enterprise which, in practical importance and lucrative results, is admitted to be one of the greatest ever undertaken. The practical point would seem to be how to prevent the work from passing into hands outside of this coast. The work runs for four miles through and into a mass of ore which, only punctured here and there for comparatively a few feet on the top, has disclosed to the world a value of $130,000,000, of which $55,000,000 has been sent into the markets of the world. Those punctures have been made at a cost of very many millions, on the mere hope of getting the ore, and without any guarantee either that the work would be prosecuted, or that, if the ore was struck, Congress would confirm the title. In the present case, a horizontal shaft or tunnel is to be run through well known districts, and Congress has given 6,360 acres of land to be selected, and the "title to mines" for 2,000 feet each side of the tunnel. The value of this land will be several times the whole cost of the tunnel, and when the $300,000 now asked for as advance expenses from the mines shall have been expended, 3,000 feet will have been driven, and other capitalists will then only have to take valuable lands, and the rights they carry with them, for the expenditure of the remainder of the money;—that is, they will have a property worth $4,000,000 put into their hands for the expenditure of $1,600,000, with the prospect that the completed work will be worth $5,000,000 in addition. And we are asked what guarantee is there that they will take it? The guarantee is the well known principle of self-interest, which is "never at fault and always effective." When the necessity of building the Erie Railroad was presented to the citizens of New York, no person supposed that it would pay as a stock enterprise, but merchants subscribed on the principle that the work was a necessity to the general business of the city. They subscribed $1,500,000 without asking any guarantee that the remaining $8,000,000 of the estimate should come from other parties. The subscription started the work, and it was built. The Comstock Tunnel is not only a great necessity to existing interests of vast importance to the coast, and indispensable, to the mines, but is of itself one of the most promising enterprises that are now on foot. The Illinois Central Railroad long lay dormant although Congress had granted it aid in the same manner that it has aided this tunnel. Finally, citizens of New York took hold and advanced the money to build the road for the sake of the land, which has realized some $25,000,000. The tunnel is comparatively a paltry undertaking, but promises much greater results.

From the "Alta California," San Francisco, December 19, 1866.

FINANCIAL AND COMMERCIAL.

The immense amount of bullion lying waste in the Nevada mines by reason of the high cost of extracting and reducing low-priced ores, has long been a source of surprise and regret, but there seems to have been no ready remedy present itself. The proposed tunnel offers that remedy effectually, and the saving which it will occasion when approximated will surprise even many miners. It is not generally known that the Comstock Lode requires motive power either by steam or water; that Virginia City and Gold Hill are destitute of either fuel or water, except what is brought thither and sold at very high prices. The water is now pumped out of the mines by engines, of which the first cost is very expensive. They are run with wood, which costs $16 per cord, and it requires three cords per day to run a small engine—say $50 per day for wood. Other expenses, with wear and tear of engine, interest, etc., raise it to $100 per day. This suffices to raise water 300 feet. The cost of hoisting ore is in the same proportion, and both increase rapidly with the depth. At the present depth, it costs $2 per ton to hoist the ore, but when it is at the pit's mouth there are no means of reducing it, and it must be hauled

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in wagons, at a cost of $5 per ton to the mills, which are situated where they can use the water pumped out of the mines, and which is sold to them by water companies at a rate per inch. To hoist and transport ore there costs $7 per ton This item, with other disadvantages, makes it impolitic to disturb poor rock, or that which ranges $10@$30; but there is a great deal of this rock. In the Savage mine alone there are now exposed 400,000 tons. In all the mines not less than 4,000,000 tons, which is useless, but which contains, on justifiable estimates, $80,000,000 of bullion. Now, the tunnel proposes to carry that ore from its present position to the mill for $1—that is, it agrees to do for $4,000,000 what cannot now be done for $28,000,000. By so doing, they will add $80,000,000 to the 52,000,000 which the Comstock Lode has already given to the world, and will put $10,000,000 into the pockets of existing shareholders, even if not another ton of new ore is discovered.

* * * * * * *

Inasmuch as that the tunnel runs in under the mines, there will be no more hoisting, no more dear fuel, expensive engines, high salaries, and costly machinery. The miners alone will dig the ore from above, which will fall by its own gravity to the tunnel for transportation, which will also draw from above not only the surface water which now drowns the mines, but those vast subterranean lakes in which it is known surface water has collected, and which are only waiting the descent of shafts from above to defy the capacity of the most powerful machinery to exhaust them. Those vast bodies of water coming through the tunnel to its mouth will leave the mines completely dry, and supply power to turn all the mills at the mouth of the tunnel, and to which must be conveyed the ore.

From the "Daily Alta California," San Francisco, December 28.

FINANCIAL AND COMMERCIAL.

The Stock market was under bear influence this morning, and many prices receded. A number of telegrams were sent down to depress certain stocks. There was again no quorum at the annual meeting of the Gould & Curry, and an adjournment took place to the 15th January. Business of immense importance to the stockholders was thus laid over. This is a remarkable instance of the want of interest taken by stockholders in the business of the company. Here is a property of $800,000 value in a mine which has given some $10,000,000 treasure to the world, and the interests of which absolutely require the attention of the stockholders. Yet interest enough cannot be got together even by proxy to transact the business; yet these same stockholders will grumble about the management of the mine. The same general inertness induces hesitation in acting upon the Sutro Tunnel. It will take "too long." Suppose the farmers should neglect to cultivate land on the plea that it takes a year to realize, what would become of the community? A great State can be built up only by timely forecast. When Mr. Astor, sixty years since, settled Astoria on this coast, he did not expect to realize in fifteen years. But the results were enormous.

From the "Daily Alta California," San Francisco, December 29, 1866.

FINANCIAL AND COMMERCIAL.

The Stock market was depressed under bear influences, and lower quotations were generally made. The accounts from the mines themselves, through reliable channels, were never better. The production is large, and satisfactory in respect of profits. The whole mining interest is being greatly developed. In this connection we may notice the query of a correspondent in relation to what he calls a guarantee that the remaining subscription to the great Sutro Tunnel will be taken up. This reminds us of the successful bet of the English sporting gentleman—that he would stand at a corner and offer to sell genuine sovereigns for a shilling each and that no one would buy them. The fact of their cheapness destroyed confidence among those not expert in metallurgy. The only wonder is, in relation to the tunnel, that the stock is not already scrambled for at a premium. What are the facts? A mountain ledge four miles long has been punctured in fifty different places at an expense of $40,000,000. It has given $55,000,000 to the world, and is now giving $16,000,000 per annum. Every one of

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those punctures has been a hazardous experiment, but almost every one has disclosed the ore which forms part of the mountain. There never was any hesitation in subscribing money for those experimental mines. Between that mountain ridge and Carson river, four miles off, are two other ridges known to contain ore. Now the proposition is to drive a horizontal shaft through these two ridges into the Comstock ridge. What is to be got by this? 1st. Congress has given the company 6,500 acres of land, worth $3,000,000. 2d. Congress gives the company *the title* to all the mines it discovers for 4,000 feet on every lode. 3d. All mines—and there are many, in the Silver Star District, in the Flowery District, etc.—abandoned for want of means to go deeper, belong to the company. These land and mining grants are worth at least $6,000,000. It will be borne in mind that the existing mines have spent some large sums boring from the surface a few hundred feet for the chance of finding ore, of which the title is in Congress. This company bore four miles through a country known to be full of ore, and the whole of which belong to them on its development. They are not boring at haphazard, but where they know the ore lies. The process of opening this great tunnel, so to speak, brings them to the Comstock Lode, 1,400 feet lower than the mines on its surface, which must stop sooner or later, unless they have an underground outlet for water and poor ore. This necessity for their existence is offered by the tunnel. Through that will flow the water, the waste rock, the poor ore and the timber, at very small comparative expense, but that expense for the mines is a revenue for the tunnel. But, may say our friend, how do you know the mines will use the tunnel? First, because the act of Congress *makes the title of each mine subject to that condition*, but chiefly because they will readily pay the tunnel $5 for what would otherwise cost them $50. Thus, the drainage, transportation of ore, men, waste rock, timber, etc., now costs the mines $8,000,000; at the depth at which the tunnel proposes to do it for $2,000,000 per annum it would cost the mines $20,000,000;—that is to say, the tunnel will save them $90 in 100, and the tunnel will have a revenue of $2,000,000, or 100 per cent. per annum on its cost, supposing the production no greater than now, but it may be three times as much. Thus, then, a certain revenue is provided of 100 per cent. per annum, the title of all mines on a line of four miles, and 6,500 acres of selected land, worth together $6,000,000, are offered to the subscribers of $2,000,000 to build the tunnel. This will make each subscribed $100 certificate worth $300, and the revenue will pay on that value 3 per cent. per month up to 15 per cent. per month. And our friend asks, "What guarantee have we that people will subscribe?" !! Truly, friend, what guarantee, indeed!

From the "Gold Hill Evening News," of December 29, 1866.

THE DEEPEST SHAFT IN NEVADA.

For a long time past but little has been said in regard to the Belcher Mine. This mine is located a short distance below Gold Hill, on the American Flat Toll-road. The claim was located in 1859, by Belcher & Company During its early history it was a bone of contention, and was sold several times at constable sale. Finally, however, good paying ore was found, and the Belcher soon became one of the favorite mines of Gold Hill.

* * * * The lower or 900 feet level is now in about 100 feet, but owing to the sharp pitch of the ledge it is thought it will require a tunnel of 600 feet to reach the ledge, which will bring them nearly under the Rhode Island Mill, on Main street, lower Gold Hill. * * * * *

By the use of machinery, excellent air is kept in the mine, although it is exceedingly warm. A double shift of eight-hour men is kept employed in the lower level, *it being so hot that it is impossible to work more than a few minutes at a time without stopping to rest*. We are informed that it is not uncommon to see the workmen with perspiration running over the tops of their boots.

From the "Gold Hill, Nevada, Evening News," of January 21, 1867.

SOME OF THEM.

Below we give some of the benefits arising from the projected Sutro Tunnel, when the great work is done. In the first place, we will make an estimate of what would be saved on freight of the ore taken out, even at the

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present time from the mines: Ophir 50 tons per day; Gould & Curry 150 tons per day; Savage 150 tons per day; Chollar-Potosi 75 tons; Imperial and Empire 150 tons; Gold Hill, proper, 200 tons; Yellow Jacket 175 tons; Crown Point 125 tons; Kentuck 100 tons; Belcher and others in Lower Gold Hill 100 tons. Thus making a total of 1,425 tons per day. The present cost of delivering this ore on the Carson river and at other points where it can be reduced, will cost not less $5 per ton. But through the tunnel it may be delivered for one dollar, thus saving on transportation alone $1,710,000. The next point is what may be saved by using water power instead of steam in the reduction of ore, would save some $8 per ton; but to make a low estimate we will place it at $5 per ton, making another saving of $2,137,500. In these two items alone we see a saving of $3,847,500. We see by this estimate that the savings of one year would do the work contemplated. In addition to this the amount saved in hoisting and pumping, would amount to at least double that amount The great benefits arising from this tunnel are incalculable, and the sooner our mine owners wake up to their interests the better. The work must be done sooner or later, at all events, and why not begin at once? * *

FROM THE "DAILY CARSON APPEAL" OF JANUARY 25, 1867.

LOCAL AFFAIRS—THE GREAT SUTRO TUNNEL PROJECT.

We are glad to know from Mr. Sutro that there are encouraging prospects, that this magnificent enterprise will receive, within a short time, the aid it needs to give it a start, and he confidently hopes the work to be commenced early in the coming summer. *It is unfortunate that the State of Nevada is not in a condition to take this matter in hand*, and preserve to itself a share of the profits, which it promises. Mr. Sutro will leave, on business referring to the tunnel, for the Atlantic States, in about a month.

FROM THE SPECIAL CORRESPONDENCE OF THE "SAN FRANCISCO TIMES," CARSON CITY, JANUARY 25, 1867.

THE SUTRO TUNNEL.

* * * * * In one way and another, a vast amount of the best sort of influence is being brought to bear in favor of this work; and for the sake of Nevada in particular, and the country in general, we must needs hope that the Tunnel Company's efforts to raise the needful funds may be speedily crowned with success; and with the progress and ultimate completion of this work, and interwoven with all its grandeur and glory, should be the fame of that marvel of energy and perseverance, whose name is so ineffably identified with its conception and construction. I had a talk with Sutro, yesterday, and he feels confident that the work will be commenced some time during the coming summer. I believe, he has left here for San Francisco. He will go East again in a about a month.

FROM THE "GOLD HILL, NEVADA EVENING NEWS," OF JANUARY 30, 1867.

THE "SUTRO."

* * * * Really, we are more indebted to the maps and pamphlets and conversations of Adolph Sutro for what little of true reputation we have, as a mining district, in the Atlantic States, than to any and all other causes favorably combined. He has procured the lithographing and judicious distribution of a series of accurate diagrams of the Comstock Lode, from which we have very substantial returns in the form of strictly correct New York newspaper articles on the situation, development and prospective product of *the* mines of Nevada; and following these come investments, large and intelligently made, by Eastern capitalists, whose interest

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it is of first importance to draw in this direction. And during the present year we shall undoubtedly realize a remarkable benefit from the same, in the form of emigration of a character most suited to our needs. So, in his preliminary work, his prospecting for capital to be placed in the grand project, Mr. Sutro has done much to enhance the general prospects of the country. The letter press of his admirably written pamphlet has been translated into German, and affords truly excellent immigration tract-talk for our most desirable trans-atlantic neighbors, of scientific mining school education.

From the "San Francisco Market Review," of March 19, 1867.

* * * * "The rate, at which many of these companies are going down upon their lodes, exhausting in some instances the entire body of pay ore, should admonish them how soon their claims will be brought to a condition when, without the aid of this tunnel, they can no longer be worked to advantage, owing to the expense attendant upon drainage and the raising of their ores and debris to the surface. Even now, when but a comparatively small lifting power is required, the margin for profits with some of them is quite narrow, indicating a point at no great depth below present workings where it is likely to vanish altogether. The Sutro Tunnel, if commenced at once, could not be carried forward to a point where it would relieve these mines of their increasing burdens, short of four or five years.

* * * * * Through the assistance of the proposed tunnel, which is to tap the Comstock Lode at a depth of some 1,800 feet beneath its croppings, mining engineers are of opinion the various mines situate along it could be worked with profit throughout their entire line, to a depth of 3,000 feet or more, a consideration that should not be without weight with the present stockholders, and in which even the public to some extent, are interested, the product of this vein the past year having approximated $15,000,000, constituting the principal source of revenue and the main support of the State, in which it is situated."

From the "San Francisco Times," January 31, 1867.

AN IMPORTANT DOCUMENT.

In this edition of the Times is published the Memorial of the Nevada Legislature, addressed to Congress, and the report of the Committee on Federal Relations upon the same, made to the Legislature. We desire to call especial attention to this report, which embodies more valuable and practical information upon the subject of mines, mining and minerals, than can be found in the same space elsewhere.

Notwithstanding the fact that the States and Territories of the Pacific slope have had many years of experience in mining, our knowledge of the science—for a science it is—may be justly considered as being yet superficial. While the array of figures and facts, presented in the report to which we have alluded, may discourage some, but no intelligent man can rise from its perusal without being conscious of gaining new mental strength.

From the "Territorial Enterprise," Virginia, of April 28, 1867.

MORE ENCOURAGEMENT FOR THE SUTRO TUNNEL CO.

As most that has been said in urging upon the attention of capitalists the importance of the speedy carrying out of the Sutro Tunnel project has had reference to the drainage and development of the Comstock Lead at a great depth, we propose to suggest a few other reasons for the undertaking of the great work—granting all that has been said of the great benefit to be derived from tapping the Comstock by such a tunnel as the Sutro is intended to be. The reasons we would suggest for the running of the tunnel, aside from the urgent necessity

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there exists that it should be run to drain and develop the Comstock, are that many other valuable leads are likely to be discovered during the progress of the work, and some that are now being worked will be cut at almost as great a depth as the mines on the Comstock. At the time the project of running the great tunnel was first agitated by Mr. Sutro, little if any work was being done on the many leads cropping out to the eastward of the Comstock and on the line of the tunnel. These ledges were either not thought of then or were not considered of sufficient importance to be mentioned; now, however, they are attracting much attention and some are yielding paying ores. The Occidental, lying nearly two miles east of the Comstock croppings, has been yielding paying ore for over a year—in fact at least one mill has been constantly engaged in reducing ore from the mine for that length of time. Now here is a paying mine, lying midway between the mouth of the tunnel and its terminus, about which nothing has been said. About half a mile east of the Comstock is another mine, the name of which we do not just now remember, from which ore is being taken at the present time which will mill (so say good judges) at least $25 per ton; and not very far from this is still another lead, known as the Palmer, from which equally as good ore is being taken. At both of these mines ore is now being saved for milling. Beyond the Occidental, in Silver Star District, and within half a mile of the mouth of the Sutro Tunnel, are a number of large leads, the croppings of which are even more promising than were those of the Occidental About one of these leads—the St. John's—we remember that there was at one time much excitement, very fine ore being found in it. None of these leads have been much more than scratched over. The Sutro Tunnel will cut them all at a very great depth, and it will be more than strange should none of them prove good and extensive veins. Since the great and unexpected dip to the eastward of the Comstock has become generally known, and since the Occidental has proved a paying mine, work has been resumed on more old claims, and there has been more well directed prospecting done in that direction than anywhere else in this vicinity As the course of the Sutro Tunnel will be directly across all the leads, known and unknown, in the section of country through which it will pass, the chances are that valuable veins will be found of whose existence there is at present hardly a suspicion. The above hints are certainly worthy of at least a passing thought by the Tunnel Company—the Comstock Lead is, we know, the first great object, but it is not all in all.

From the "Daily Evening Bulletin," of April 5, 1867.

REPORT ON THE SUTRO TUNNEL.

At a meeting of the members of the Mechanics' Institute, held last evening, a Special Committee, consisting of W. J. Lewis, Archibald Cooper, and P. M. Randall, made a voluminous and interesting report on Mr. Sutro's project to drain the mines on the Comstock Lode by a tunnel.

* * * * * * In the discussion which followed it was stated by several speakers, that they considered it the most valuable document which had ever been read at a meeting of that Institute, and the Directors were authorized to confer with Mr. Sutro, and make arrangements for having 2,000 copies of the report printed.

From the Virginia, Nevada, "Daily Trespass," of April 20, 1867.

THE SUTRO TUNNEL.

* * * * * * "Manifestly, the silver was never poured from Devil's ladle down into the fissure. It must have worked up. Then, it must be pursued at greatest depths to get its greatest wealth. To work by shaft from the surface to a depth below sea-level, is impracticable. To get in by tunnel, at a depth to drain and open the whole series of mines in the Comstock, the work must be a long one; must start a long way off, in order to get under the base of the mountain; must start at or near the starting point selected for the Sutro, to be in line with the Comstock.

The Mechanics' Institute, of San Francisco, appointed a committee to investigate and report on Sutro's project. They report it feasible, and necessary to the proper working of this vast silver deposit. * *

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From the "Daily Evening Bulletin" of the 10th of May, 1867.

THE SUMMIT TUNNEL.

The Pacific Railroad people are making wonderful progress on the Summit Tunnel. Some people—even engineers—calculated that this great work would require three or four years for its completion, as if it were under the control of laggards. But here, and in the hands of go-ahead Californians, tunnel-time is annihilated. The tunnel is 1,660 feet long. It was begun in September last—at four points—on the east and west ends, and two other faces were created by a shaft in the centre. Thus there are four faces, with three sets of hands to each, or twelve sets in all. Each set works eight hours, and the work goes on night and day! And now, on the 1st of the present month, of all these 1,660 feet, there were but 681 feet remaining to be cut! The progress last week was 60 feet, and at this rate the tunnel will be completed by the middle of August next. By measurement, on the 1st instant, there were but 346 feet in the east heading and 335 in the west heading, making, as before stated, 681 feet in all to cut. And so in the space of eleven months from the period of its commencement will this tunnel be finished! (*Sac. Bee.*)

From the "San Francisco News Letter," May 18, 1867.

CURIOUS DRIFT OF THE SUTRO TUNNEL.

We turned down a leaf the other day at page 288 of H. G. Ward's book entitled "Mexico in 1827," and invite the Nevada Mining Companies, when found, "to make a note on't." For an English official, Ward is a little frisky at times, and has a sly way of putting things about Mexico and the Mexican character that reminds us of some of the best of the English humorists. But his style is only the seasoning to a ragout, mustard to roast beef, sauce piquante to a very solid fare. The work is not only lively and elegant, but also statistical, and has been standard these many years.

We hope nobody in the world will take the slightest offence at our saying that this way of referring to the Spanish style of putting the finishing touch to the greatest work ever projected in Mexico, reminds us somehow or other of the Comstock people, and the greatest work ever projected for the State of Nevada or the Pacific Empire. We allude to the grand canal near the city of Mexico, and the Sutro Tunnel.

The city of Mexico, it is known, was formerly, and is even now, in periodical danger of inundation from the filling up of the lake Tezcuco, which, high as the city is, is higher still. To guard against the danger, a subterranean canal of over four miles in length was begun, and was wholly completed in the astonishing period of eleven months. This unusual burst of Spanish enterprise is explained by the fact that the whole of this stupendous labor was forced out of the Indians, who were collected in vast numbers, and treated by their masters with dire cruelty. These Indians had then just been Christianized, and the most of them died in the faith during the progress of the work. But for fear nothing should be left to expend their energy upon in the future, the Spaniards, against the repeated protests of the engineer, Martinez, incorporated certain defects into the plan. The consequence of these was, that a rainy season of unusual violence having set in, in one night the whole town was laid under water, and for five years the only way of passing through the streets was by means of canoes. This happened in the days of old Spain's dominion, and such was the distress of the inhabitants, and so gloomy was the prospect of making anything better than a kind of ruined Venice out of the city, that orders were actually given from the Court of Madrid to abandon the town and build a new one upon another site. But a dry year, and a few opportune earthquakes cracked and rent the surface of the valley, and the waters gradually disappeared.

The defects in the plan were not, however, remedied; and so stands the canal, and so threatens the lake at the present hour. These opposing forces have a heavy brush occasionally for the possession of the capital, but there has been no general engagement along the whole line for some years past. Ward tells us of the philosophical indifference of that energetic and far-seeing race to the canal and the lake in a dry season, and the consternation

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of the Mexicans, and their spasmodic labor on the work in a season of freshet. A few thousand dollars, he says, would remedy the defect and suffice for completing the work, "which is now in a very bad state, but as it is only prosecuted when the danger of an inundation is imminent, and suspended in dry years, and as the last few years have been remarkably dry, it is probable the old Spanish system of procrastination will be adhered to." In other words, that vigorous people, having once been delivered out of a great strait by the sublimity of luck, are now trusting with true Mexican faith to the same fine piece of earthquake engineering for their next escape.

We are reminded by all this—but how or why in such a connection we cannot tell—of the Comstock people and the Sutro Tunnel. We feel the absurdity of the confession. We know how preposterous it is to have anything American remind one of anything Mexican, and that, as a matter of course, it would be just as absurd to expect the American Trustees of the richest mines now known to treat a business like the Sutro Tunnel in the real old Mexican fashion, as to expect to see them saunter up and down Montgomery street with serapes and cigarritos, jingling spurs at their heels. It is too absurd to be thought of.

But we cannot lay a ghost so easily, and the association of ideas comes up again. The managing agents of our Nevada mines are of course the most enterprising and long-headed of their class. They know what caused the ruin of the most famous mines on this continent. Humboldt told us—many years before the Comstock was christened—of the follies committed with the rich veins of Mexico; how hundreds of thousands were wasted in hoisting and pumping, and hundreds of thousands in running little tunnels here and there into little claims, when it was plain common sense to construct one main tunnel of sufficient length to drain and work an entire lode from end to end. But such follies belong to, lo! the poor Mexican. Our boards of Trustees are not waiting for the intercession of the saints, or a ten strike in the way of a stray earthquake. So much is clear.

The Sutro Tunnel project has only been two years and a half in agitation, and, in view of the imminent nature of the case, the boards have already concluded to take under advisement the question of taking into contemplation the propriety of giving a serious consideration to that important matter—in the course of the next few years. Now this looks something like business! This is what we call taking action in the true spirit of the thing!

Notwithstanding all this right American dash, it came to pass, nevertheless, that in reading Ward's description of that ever-to-be-postponed and never-to-be-ended Mexican canal, the Sutro Tunnel got into our head, and kept coming back as we went on in the reading, until time and place, and subject got jumbled together, and we really thought the author was giving sly digs at *our* subterranean canal. The sarcastic rascal had never heard of the famous tunnel that is now being so vigorously handled by our Trustees, and perhaps never saw it even in a vision, and yet he seems to go on and on in this strain, and it is still ringing in our head: "But as the construction of the Sutro Tunnel is only thought of when the danger of an inundation and the exhaustion of ore is imminent, and all action about it is suspended so long as the ore is in sight, and as the last year has been remarkably good for those who can see it, it is probable that the old system of procrastination will be adhered to."

MORAL.

Never provide against a rainy day—it may never come. In a dry year do not dig a canal—it is not wanted. In a wet year it will be of no use, as the flood has already arrived. Do not mend your roof in dry weather—it does not leak; when it rains nobody but a fool will work out of doors. Leave your stable door unlatched—your horse is safe enough against honest people. But if you find he is stolen, then clap on a patent padlock without delay. If you are a miner, do not provide a pump so long as water is not in your mine—you could not use one if you had two. When your works are drowned out and ruined, the damage is done, and the only way is to make the best of it. Do not build a tunnel so long as you can hoist a pound of ore—The proof that you can always hoist is that you *are* hoisting. Nor so long as you can rig up machinery enough to keep the water down. Pumping is cheaper than letting water run down hill, and the proof that you can always pump is that you *are* doing it. Nor so long as you have ore in sight and feel happy—for what more do you want? Besides, while your mine is rich and wouldn't miss the money, you are getting on famously without it. When your mine and money are spent, you will want it bad, and that will be just the time to build it. Build it then, by all means, or, what is the same thing, wish you had it—wishing does that sort of jobs.

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Extract from the Commentaries on the Mining Ordinances (Ordinanzas de Mineria) of Spain, by Don Francisco Xavier de Gamboa. Second vol., page 299.

"The work of Senor Gamboa, which was, previous to the year 1783, the *paramount authority* in all doubtful cases of mining affairs, continued, after that date, to be regarded with the highest respect, and was and is still, constantly referred to in the Courts of Mexico, and as is presumed, of the other new republics of America also, as a great authority on such subjects."—*From the preface to Gamboa's work, by Richard Heathfield, Esq., Barrister at Law, translator of the same.*

These four ordinances (which have none corresponding to them amongst the old ordinances.) *are of the first importance for keeping up the mining districts.* They relate to adits, *or contraminas*, so called, because they are levels or galleries over against a mine. The pit or shaft of a mine is opened from the surface above, but an adit is opened from the foot or side of the hill, and driven to communicate with the pit. The pit, therefore, descends from the surface towards the centre and the adit ascends to meet the pit or pits of the mine. The arrangement of these works, thus explained, is sufficiently clear and intelligible, but may, if required, be seen in various plates given by Agricola.

These *contraminas*, or adits, which are vulgarly called *cañones*, (levels or drifts.) are subterraneous conduits or channels, and have for their principal object (amongst others) to collect together the water from several mines, *affording one general means of drainage for all of them*, and thus rendering it practicable to work parts of the vein previously under water. *This is the grand object of a contramina or work of general drainage.* Pits are expensive works, and often become insufficent or unserviceable, either from variations in the course of the vein, or from the great pressure of water in the deeper levels.

But an adit, or contramina, *whilst it is a durable and permanent work, provides an outlet for the waters, in their natural course, affords a ready ingress and egress to the workmen, for the purposes of getting out ore and rubbish at a reduced expense, gives opportunities for exploring the principal vein of the mine, and the other veins connected or forming junction with, or dividing or intersecting it, and, by determining the course of the vein, and enabling the proper direction to be given to the different works, promotes the grand object of discovering and turning to advantage the metallic substances hidden in the bowels of the earth.*

Upon these grounds then, *contraminas* being works of the highest importance, both for giving permanence to the mines themselves, and for facilitating their present working, it is provided by the 79th ordinance (notwithstanding the rule that no one ought to be compelled to work his own property) that such works shall be driven, whenever there are conveniences for the purpose; the mine owners contributing thereto, according to the benefit they may derive from them; and that if they shall not agree, the justice shall apportion the expense, and compel them to make good the payment.

The first thing, therefore, is to ascertain the disposition of the ground, etc., etc.

In the second place, after considering the disposition of the ground, the attention must be turned to the arrangements required to be made amongst the mine owners, preparatory to driving the adit. This is the greatest difficulty in carrying the 79th ordinance into effect, for although it directs that adits shall be driven whenever there are conveniences for the purpose, or that the owners shall be compelled by the justice to drive them; *yet the fact is that the labor of these undertakings is so great, and the miners so necessitous and destitute of resources*, that unless they happen to be men of very ample means, they are but rarely in a situation to undertake an adit of great length, or to expend many thousands of dollars in advance, upon the bare hope of reimbursement upon the draining being accomplished. On the other hand, if the business be made a partnership concern, the love of money becomes a great bar to its success, and the profit not being of a nature to admit of easy division, it so happens that very few instances occur, of agreements between different parties for undertaking these adits in concert. *The miners, provided they have but some ore to work at for the time present, pay but little regard to the prospects of a greater profit at a future period, and are alarmed at the idea of expense.* They are satisfied with a small profit, and with the ordinary mode of drawing off the water by means of the pit, and they cannot find courage to form a combination for the purpose of driving an adit, not calling to mind, that after a little time, when the works are carried somewhat deeper their pits will become of but little service, *whilst an adit or contramina would provide for the permanent and continued working of the mine.*

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All these causes combined, render it difficult to put the directions of the ordinance in force, *and will in time be the occasion of the ruin and abandonment of the principal mining districts*, and indeed may now be observed to operate sensibly in some of them, more particularly in the rich veins of the mining district of Guanajuato, which has been the Potosi of New Spain, and in those of Pachuca and Zacatecas, which have yielded riches beyond calculation. The productiveness of these veins is matter of notoriety, and has been long well established, and yet a vast number of their mines have been abandoned, on account of the force of the water, notwithstanding the disposition of the ground is such, that the obstacle might have been overcome, had the owners been inclined to combine in the important undertaking of driving an adit, and so clearing the water from their lower works, which are more liable to be embarrassed by it, in proportion to their depth. And as the source of this water, being the rain which falls, is of permanent continuance, there is room to apprehend that the principal known deposits of treasure will in time cease to be worked, and that the very circumstance of there being such an abundance of mines, will be the cause of their becoming altogether unavailable.

Such are the evils which may be anticipated from the non-observance of these ordinances, *which are conceived with every view to the public benefit*, as is evident from the clear authority given by the 82d, to any person, to drive an adit through the mine of another proprietor, and the express direction of the 81st, that the proprietors shall come to an understanding, or that the justice shall bring them to an agreement. But it is to be observed, that it is advisable that the miners should bring in their contributions, whether voluntary or compulsory, when the state of their mines is such as to supply them with funds for the purpose; that is to say, when they are in course of prosperity, although liable from their increasing depth, to be soon embarrassed with water; for if they defer it till the water overwhelms them, the circumstance of their money being spent, and the works inundated, renders that difficult to apply as a cure which would have been easy as a preventive.

We have already noticed the lamentable neglect into which the working of the mines of Spain, the fruitful sources of immense treasure, has fallen. And there can be no doubt that one cause, which contributed to the abandonment of the richer districts, was the embarrassment occasioned by the water, *and the omission to drive adits and contraminas*. This was the case with the rich mines of Guadalcanal and others, belonging to the crown; in which, as well as in other mines of that kingdom, torrents of water broke forth, at a time when they were in most active work.

The same misfortune happened with the mines of Carthagena in the time of Hannibal; and, although one of this latter alone, named Bebulo, from its discoverer, returned him 3,000 crowns a day, it was only in consequence of an adit having been driven by the Carthagenians with immense labor, through the mountains, for the length of 1,500 paces, through which the water was let off, forming a complete river, as is testified by Pliny.

Peru again, in its vast extent of surface, offers many deposits of gold and silver, as does New Spain, both in its cultivated and its remoter provinces; but there is reason to apprehend, that from the non-observance of these ordinances, the mining districts of the more populous and fruitful provinces will go to decay, although it would be easy, and at the same time to make a considerable profit, merely by driving adits or *contraminas*, to drain the principal districts, such as, amongst others, Guanajuato, Pachuca, Zacatecas, Tlalpujahua, and Sombrerete, the known and approved richness of which promises the greatest advantages from such works.

We know that the mine of Quebradilla, in Zacatecas, when worked by a partnership formed in the year 1741, yielded in six days and a half $260,000, after which a spring of water broke out in one of the ends, with irresistible force, and inundated the whole vein, which is about twenty-two varas in width; and hence it appears how advantageous an adit, or work of general drainage would be, if undertaken. And the same may be said of other mining districts, where nothing but the water prevents the obtaining possession of the mineral treasure.

Considering the profit the crown derives from the duties on the silver and gold produced from the mines, which profit must diminish as the mines decay, it would certainly answer to the revenue, in districts of tried and approved richness, to assist the unfortunate miners, in providing means of drainage by contraminas. *It has, it is very true, been found by experience, not to be desirable for the crown to undertake the working of the mines, nor even to take on its own account the mine, which, under the old ordinances was set apart for it, contiguous to the discoverer's mine, on account of the risks to which the revenue would be thereby exposed*, and because, there being plenty of persons willing to work these mines, the crown is graciously pleased to be contented with the fifth, tenth, or other proportion justly allotted to it: *but these reasons do not apply to the driving of an adit in a mining district of notorious richness*,

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when the presence of the water is the only obstacle to the working of the mines the situation of the latter being such as to afford facilities for the purpose. *For in such a case there is, morally speaking, no risk at all*, and the crown might have the benefits of two-fifths, or tenths; one by virtue of its original right, and the other in consideration of the funds expended upon the work of drainage. So that the work being performed on the part of the crown and the miners together, the loss would be but trifling, even supposing it to fail of effect; but if it should succeed, the advantages to both would be very considerable. Although this is a subject for the judgment of the sovereign and the discretion of his ministers, we think we should be wrong did we omit to place it in this point of view.

Having suggested these reasonable reflections on the important subject of executing works of general drainage in mining districts of approved richness, we proceed to remark, that although it is evidently difficult, in general, to accomplish such works by the exertions of a set of individuals, both from their wanting the means, and from none but mine owners being willing to risk their money in adits, when there is no certain prospect of reimbursement; and that the water sometimes lies at such a depth, that it would be necessary to drive some leagues to give the adit a proper slope; yet it is notorious that in many mining districts, where the circumstances are much less unfavorable, a great number of whims are often employed by different mine owners in the laborious business of draining, (raising the water through pits,) a plan which is attended with the disadvantage of leaving the works always liable to be overwhelmed by a fresh influx of water, *in consequence of which the property of the miner is exhausted, and the public interest prejudiced by the necessity for repeated drainage.*

But there are also places, where, from the disposition of the ground, adits might be made at very little expense, and therefore, in these instances, it is evident that the only reason for the non-observance of these ordinances, must be that the proprietors do not agree among themselves. And whether it be from the connivance on the part of the justices, or from ignorance of their duty, it is very certain that they neglect to enforce the rules of these ordinances, insomuch that we never recollect to have heard of their resorting to compulsory measures for the purpose, or of their treating with the miners, in order to stimulate and encourage them to a better practice.

By indulging in this neglect of their duty, they do injustice to the public, to individuals, and to the rights of the sovereign, who has made it a law, that the working of the mines shall be assisted by means of adits, as being works of great importance, and necessary for giving a permanent character to this valuable description of property.

Letter from John Stuart Mill, Member of the British Parliament, etc., etc.

Avignon (France,) *November* 30, 1867.

Adolph Sutro, Esq.

Dear Sir:—I have only to-day received your letter of November 27, and the papers to which it refers have not yet reached me. My absence from England prevents me from having the interview which you propose; but since you appear to wish for my opinion on the influence, which the increase in the production of the precious metals exercises on the price of commodities, I can at once say, *that I consider that influence to be very great*, and greatest in the places in which the general rise of prices has hitherto been the lowest.

I am dear sir, yours, very faithfully,

J. S. MILL.

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United States of America: State of Nevada.

Senate Concurrent Resolutions No. 70

IN RELATION TO

ADOLPH SUTRO.

Resolved, by the Senate, the Assembly concurring:

That the Legislature of Nevada recognize as already due, and cordially extend the thanks of the People of this State, to ADOLPH SUTRO, *for his great services in originating the plan of the* "SUTRO TUNNEL," *and urging aid and organization for undertaking work upon the same; and be it further concurrently*

Resolved, *That we have entire confidence in the ability of Mr. Sutro to present to Congressmen and capitalists the claims of the enterprise referred to, knowing that he will prepare with skill, and clearly exhibit, the whole statistical and politico-economical argument bearing in its favor, without overlooking or exaggerating any of its merits.*

January 25th, 1867: Read and passed unanimously.

B. C. Brown,
Secretary of the Senate.

James S. Slingerland,
President of the Senate.

Received from the Senate January 25th, 1867: Read and passed unanimously.

A. Whitford,
Clerk of the Assembly.

R. D. Ferguson,
Speaker of the Assembly.

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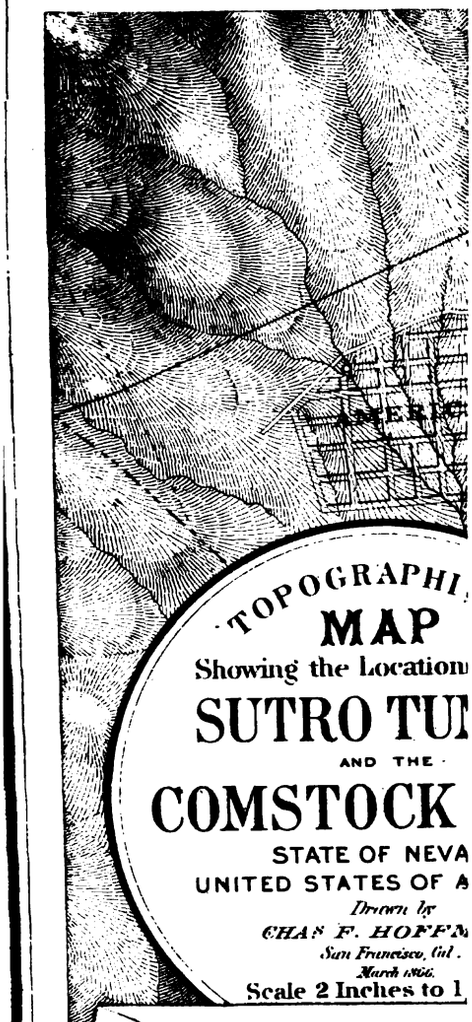

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